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NEW SEA-GOING DREDGES.*

By Day Allen Willey.

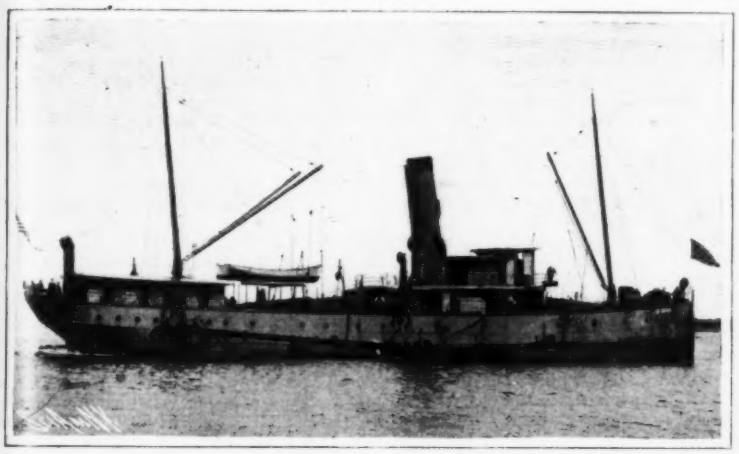
The improvement of the ship channel leading into New York harbor has given an opportunity thoroughly to test the merits of what is generally called the sea-going dredge. The government engineers calculated that to secure a channel of the dimensions required no less than forty-two million cubic yards of material must be removed, for the channel will be about seven miles in length with an average length of 2,000 feet, and a depth of 40 feet at low tide.

The problem which the engineers were called upon to solve was how to remove the material in the most economical manner and in the shortest interval practicable, as well as to deposit it where it would not form an obstacle to navigation. The employment of the ordinary dipper or bucket dredge dumping into scows was decided to be too expensive, and a task which would occupy an indefinite period. The long distance to which the debris must be carried rendered the use of pipe lines for conveying it to dumping grounds impracticable. The possibility of the dredges being sunk or damaged by heavy seas owing to their exposed position also had to be taken into consideration. The plan by which the entrance to Liverpool harbor is kept at sufficient depth was studied, with the result that two sea-going dredges were ordered to be built, modeled somewhat on the lines of the type in use at the mouth of the Mersey. These have been in service since May, 1901. They are similar in capacity and dimensions, being 300 feet in length, 52½ feet beam, and drawing 22½ feet of water when loaded. Each is provided with a suction pipe, the lower end of which terminates in a series of heads with 8-inch openings, through which the sand and mud are taken. The necessary suction is provided by a centrifugal pump operated by two tandem compound engines, each having cyclinders 17 by 30 inches in diameter with a 30-inch stroke. The suction tube is suspended in a well in the center of the dredge into which it can be raised when out of service. The material as it is taken through the pipe is conveyed into a series of hoppers so arranged that a large proportion of the water taken aboard passes off through the scuppers and is not discharged into the hoppers.

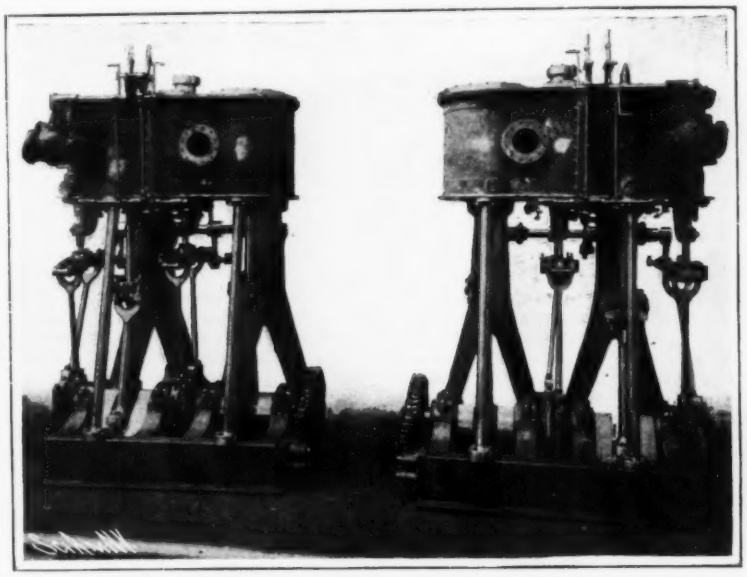
The capacity of this type of dredge ranges between twenty thousand and twenty-five thousand cubic yards to a working day. Last year, however, two more dredges have been added to the fleet of excavators, which are of far greater capacity and contain a number of notable improvements. The hulls are strongly constructed of mild steel and are of such a model that they can be kept at work in stormy weather, as a heavy sea must be on to prevent operations. The "Manhattan" and "Atlantic" are also similar in dimensions and other respects, being 288 feet in length over all, 274 feet in length between perpendiculars, with 47½ feet beam, and 25 feet depth of hull. The total hopper capacity is 2,400 cubic yards. When light they draw but 9½ feet of water, consequently can be navigated in shallow water. When loaded to their greatest capacity, however, they draw 2½ feet less than the other type of dredge, but as already stated, are of much greater capacity.

The principal difference in the vessels is in the installation of the suction machinery. Instead of one pipe, each vessel is supplied with two, each of 20 inches diameter. There is no well in the center of the hull, however, as the pipes are attached to the exterior of the hull. Each pipe is no less than 98 feet in length and composed of metal and fabric, the section connected with the pumping apparatus being really a piece of flexible hose ten feet in length, which is fitted into a steel socket. This arrangement allows the pipe to be readily raised and lowered and to adjust itself to the motion of the vessel. The lower end terminates in a steel drag, or mouth, which is widened out in order to cover more surface. To the mouth is attached a steel blade which assists in loosening the sand or other substance to be removed. As the pipes are attached to the vessel by what can be termed a movable joint, they can be kept in service while the dredge is under way, and it is not necessary to anchor in order to perform the excavation.

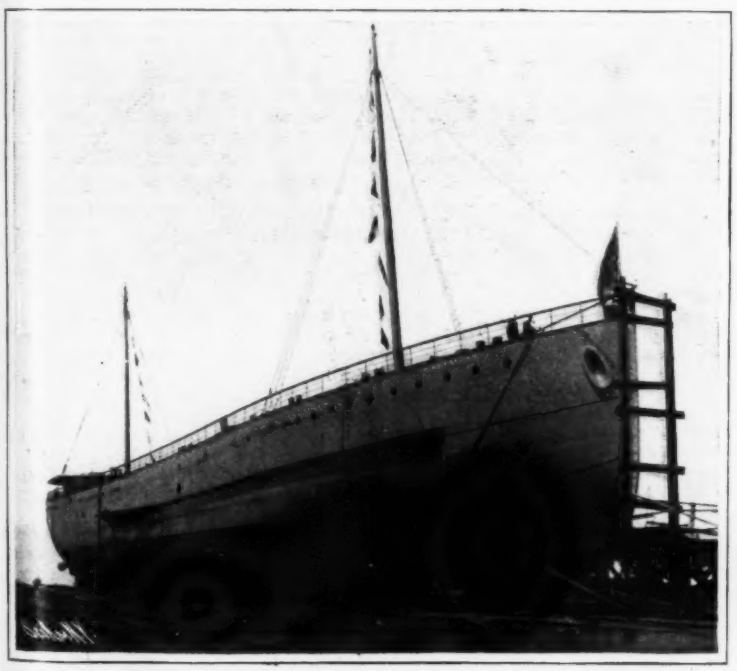
As the photographs show, the suction pipes, when not



DREDGE IN COMMISSION, SHOWING SUCTION PIPE.



TYPES OF PROPELLING ENGINES OF SEA-GOING DREDGES.



THREE-QUARTER BOW VIEW OF A SEA-GOING DREDGE ON THE WAYS.

VIEW FROM AMIDSHIPS. FILLING COMPARTMENTS WITH DEBRIS FROM PUMPS.

NEW SEA-GOING DREDGES.

* Specially prepared for the Scientific American Supplement.

in use, can be hauled up against the side or on deck and fastened in slings so that they will not interfere with the motion of the dredge when under headway. The steel socket which forms the upper end of each pipe is connected with a series of other pipes carried under the main deck to a point near the hoppers. Then they extend upward through the deck, discharging into sluices provided with gates which distribute the material to the hoppers after the water, which can be released, has drained off.

In ordinary operation the dredges are moved at moderate speed over the spot to be deepened, the suction pipes dragging along the bottom. Thus the excavation is not confined to one spot, but the bottom of the channel is cut away in furrows, so to speak, and the material removed to a uniform depth in the distance covered by the suction heads. One of the disadvantages of the stationary dredge has been that more material than necessary would be taken out in places before it was moved to another point.

To furnish the necessary exhaust for the pipes, the suction apparatus is necessarily installed in duplicate, consisting of two 20-inch centrifugal pumps operated by 800-horse-power engines. The pumps can force the material through the pipes at the rate of ninety-five cubic yards of water a minute under a 16-foot head, giving them a capacity of nearly 60,000 cubic yards in a working day of ten hours. Each dredge contains two hoppers which will hold 4,800 cubic yards combined. These can be filled in one and one-half hours.

The propelling machinery consists of two compound engines with cylinders 22 and 44 inches in diameter, and 30-inch stroke developing 1,800 horse-power, which is sufficient to give a speed of nine knots an hour loaded and nearly eleven knots an hour when light. As the photographs show, the "Manhattan" and "Atlantic" are provided with twin screws each 9½ feet in diameter. The removal of the well in the center of the hull not only gives more storage capacity, but strengthens the vessel, and it may be said that they are sufficiently staunch and seaworthy to cross the Atlantic if necessary. This is a decided advantage, since a dredge of such design can go from place to place upon its own steam to engage in harbor improvement or other necessary work, while if desired it can be permanently steadied in a harbor. The expense of using towboats to move the apparatus from one place to another is avoided, while the danger of being wrecked while *en route* to its destination is greatly lessened. The advantage of this type of dredge, especially in connection with harbor work in the South, is obvious. One of sufficient capacity could keep the ship channels of all the important cities of the Gulf coast, for example, at the proper depth, going from one harbor to another without delay as fast as it completes its work.

The first dredges used in the New York harbor improvement were built for the Metropolitan Dredging Company, but the "Manhattan" and "Atlantic" were constructed for the government and under the supervision of its engineers. They may be classed as the most improved design of the sea-going dredge, being able to work not only in mud and sand, but on bottoms of stiff clay as well. At present but a little over one-third of the excavation of the New York ship channel has been completed, but with the four excavators in service the average quantity removed daily has been considerably more than doubled, and calculations have been made that the work will be completed within the next five years at the present rate of progress.

POSSIBILITIES IN HEATING WITH HOT AIR.*

By R. S. THOMPSON.

In heating with hot air, the air is heated by contact with hot surfaces in a central heating apparatus, and is then conveyed to the rooms. In heating with hot water or steam, the water is heated in the heating apparatus, conveyed to the rooms, and there used to heat the iron of the radiators, which in turn heats the air. The difference between the two systems is, therefore, practically that in the hot-air system the air is heated by one central plant, while with hot water and steam the air is heated by a separate plant or substation in each room, which substation is heated from a central station.

It is not my purpose to disparage the system of heating the air by individual heating plants, but to show some of the possibilities in heating the air by a central plant, a system which, in my judgment, has been largely left to incompetent men, and has not received the attention and scientific study which it deserves. That this system has been in a large proportion of cases unsatisfactory I freely admit, but I believe that the failures have been due to errors in construction or operation and not to any inherent defect in the principle.

Heating the air by a central plant involves less expense in the installation, and this is a matter which demands the consideration of the practical engineer. Economy in first cost is not everything, but it is something, and with probably ninety-nine out of a hundred people who have homes to heat, a very vital something. While a really first-class hot-air plant cannot be installed at the prices commonly charged for inferior and inefficient ones, yet even such a plant costs less than a hot water or steam system. Economy of first cost is, therefore, a possibility in heating with hot air.

But economy of operation is no less important. The plant is paid for once, the fuel bill is a continuing expense, and frequently amounts to more in a few years than the first cost of the plant. No system is economical which involves a continuous useless expense. What are the specific facts in regard to cost of operation in heating with hot air? A given amount of fuel will in perfect combustion set free a given amount of heat, no more and no less. The heat is in the fuel, not in furnace or boilers. No heating apparatus can add a single unit. The theoretically perfect plant would be one in which there was absolutely perfect combustion of the fuel and complete utilization of the heat released by this combustion, and on these two points depends the comparative economy of operation.

On the first point, completeness of combustion, while there is large difference in different apparatus, there is no essential difference between the two systems. The fuel can be burned as perfectly and as large a proportion of the heat units contained in it be released with one system as with the other. The issue is, therefore, narrowed to what becomes of the heat after it is released from the fuel.

Heat cannot be destroyed. Once produced, it must either be transformed into some other form of energy or continue as heat. In house heating, it may be practically said that all the heat released by combustion either goes toward heating the house, that is, to replacing that which has been lost by radiation and leakage through walls and windows, or escapes up the chimney, having performed no more useful function than the creation of a draft.

The extent to which the heat produced is utilized can, therefore, be practically determined by ascertaining the per cent which escapes to the chimney. The lower the temperature at which the waste products of combustion escape to the chimney (velocity of current being the same) the larger will be the per cent utilized for heating the house, and consequently the greater economy in operation. In other words, the extent to which the cooling of the products of combustion can be carried is the measure of the efficiency of any heating apparatus.

Let us see the theoretical limit to which the cooling can be carried, keeping in mind the fact that the theoretical limit can never be reached, much less passed, in practice.

The products of combustion are cooled by contact with metal which is cooled by contact with water or air. The theoretical limit of cooling is, therefore, the temperature of the air or water by which this cooling is accomplished. With live steam the possible minimum is the temperature of water boiling under normal atmospheric pressure, or 212 deg. With hot water the possible minimum is the temperature of the water as it returns to the boiler from the radiators, usually 140 deg. to 170 deg. With hot air the possible minimum is the temperature of the cold air entering the furnace, anywhere from below zero to 70 deg.

The theoretical limit of cooling and consequent theoretical economy in operation is, therefore, lower with hot water than with steam, and lower with hot air than with either hot air or steam. It is, therefore, possible—theoretically—to heat with hot air more economically than with any other system. But the advocates of the other systems will contend that while this may be so in theory, yet that in practice, owing to the greater power of water to absorb heat, it is otherwise, and that actually the exhaustion of the heat contained in the products of combustion is carried much further in both steam and hot-water heating than it is in hot-air heating.

In many cases, I admit the contention, but in turn I contend that the reason is to be found in the construction of the apparatus and not in the principle, and that it is entirely possible to so construct hot-air apparatus that the same difference in its favor, as compared with hot water and steam, will exist in practice as is shown in theory.

In heating with hot air, however, there is an expenditure of heat which may perhaps be called waste, namely, the heat contained in the air which is forced out of the building by the pressure of the warm air that is being poured in. But this loss of heat is due to the necessity for ventilation. A given amount of ventilation will involve the same loss of British thermal units, whatever the heating system may be. It is true, with hot-water or steam heat it is possible to reduce the ventilation below the proper ratio, and thus save heat; but this is equally possible with hot air, if the plant is so constructed that the amount of ventilation can be controlled.

It is true that with hot-air heating ventilation can be carried to a point which will involve large loss, as I shall show hereafter. The same is true with hot water and steam. You can open the windows and crowd the fire. But in either case the loss is to be charged up to ventilation, or bad management, and not to the system of heating, and can be as well controlled under one system as another.

It is a possibility in heating with hot air to heat all the rooms in the house at the same time. I am compelled to admit that this is not always done in practice. I could not even dispute the statement that it is not often done, but I can demonstrate both theoretically and practically that it can be done.

If the amount of cold air that is supplied to the furnace is equal to the amount that can be forced through all the hot-air pipes; if the construction of the furnace is such that this amount of air can pass through the casing and reach the hot-air pipes, with velocity unreduced by friction; if the furnace has the necessary surface and the necessary arrangement of surface to heat all this air; if the size and form of the hot-air pipes is such as will permit the passage of the required amount of air to each room; and if there is no serious "back pressure" in any room, the furnace will heat them all at the same time. For, if enough air is being pressed through the furnace to supply all that can be carried by all the pipes, the pressure in the furnace will force this air through all these pipes, if the resistance due to friction and back-pressure in the rooms is less than the pressure in the furnace. That is a simple matter of mathematical demonstrations.

There are a great many "ifs" in that claim? Certainly. And it is the business of the heating engineer to look after those "ifs." If he cannot do it, he has not yet mastered his profession. These "ifs" cannot be met either by guesswork or by a set of hard-and-fast rules. They require a thorough scientific knowledge of the principles involved, a considerable amount of practical experience, and a liberal use of horse sense.

Air is compressible and elastic. It is subject to friction, inertia, and momentum. The fact that two pipes have the same area is not proof that the same pressure will force the same amount of air through each. To get proportions correct is not a simple or easy matter, but requires the exercise of brains and judgment. It is possible, in heating with hot air, to heat those rooms which are most exposed to the wind, or the windward side of large rooms. The course of heated air is subject to definite laws, and by the use of these laws it can be controlled. But the man who would control it must make himself familiar with these laws and not content himself with a lot of empirical formulas.

The cause of trouble in heating rooms exposed to the wind is that the air pressure on the outside by leakage produces air pressure in the room, and if the pressure in the room is greater than the pressure in the pipe, the greater will overcome the less. If the pressure of air on the outside is so great that the pressure of air in the pipe cannot force air out through the crevices around windows, and there is no outlet for the air, it will be impossible to force air into the room, and consequently impossible to heat that room. But the difficulty can be overcome by providing a proper outlet, of the proper size and in the proper location.

Nothing has done so much to injure heating with hot air as the common idea that neither skill nor scientific knowledge is needed in connection with it. The system has been neglected by scientific men, and the work is frequently turned over to common mechanics.

There is one point in connection with heating with hot air to which I have already referred, in which there is a possibility of great waste of heat. This is over-ventilation. Take a house in which the loss by radiation from walls is 80,000 British thermal units per hour, in zero weather. To maintain the temperature by replacing this loss will require the use of 62,857 cubic feet of air per hour at a temperature of 140 deg.

Supposing the family consists of six persons, the maximum requirement for ventilation would be 11,800 cubic feet per hour. In this case we are using 51,057 cubic feet of air per hour in excess of the amount required for ventilation. If this air escapes at 70 deg. and has been heated from zero, it represents a loss of 64,963 British thermal units, or about 8 pounds of coal per hour. In my judgment, the remedy for this is to make provision for recirculating this excess of air.

* Paper presented at the Chicago meeting of the American Society of Heating and Ventilating Engineers.

PACKING MACHINERY FOR EXPORT.

THE American Chamber of Commerce at Paris, which is doing efficient work for the advancement of American trade, issues from time to time bulletins in furtherance of this object. Mr. Paul Roux, a member of that body, prepared a paper entitled, "The packing of machinery for export," which the chamber of commerce has printed in pamphlet form. The following notes are taken from the pamphlet, to which attention of American exporters is invited:

In packing goods for export care should be taken to economize space, to avoid breakage and exposure, and to be ready for rough handling. Goods should, if possible, be kept within 40 cubic feet per ton. Projecting parts should be removed and packed separately. They increase space and increase risks of breakage.

The parts should be so marked as to absolutely preclude the possibility of error. Herein will be found more than half the success of securing foreign trade. Not a single piece, no matter how simple, should be packed without its localizing mark. It is impossible to emphasize this point too much. Always dismount all fragile and projecting parts. Leave no delicate parts exposed. Plug up oil holes. Put on the best possible coating. It pays. Be sure to put on enough, particularly on all exposed parts.

Merchants and manufacturers should look carefully into the matter of weights and measures. They mean much in the questions of trade. Rates are often regulated on the weight basis. For example, goods weighing more than four and one-half tons pay, as a rule, twice as much as do those under two tons. Large and heavy bales increase the cost of loading and unloading. Packing is a science and an art. The making of boxes has been the subject of scientific and mathematical work of the highest kind. Before a box is bought or built the merchant or manufacturer should go carefully into the minutest details as to the character of the box wanted. Care should be taken to permit of easy and efficient examination of the machine or parts packed, even to the admission of a lantern to reveal the parts. For this purpose it is a good plan to fasten one side of the case with screws, usually the side that permits of the best examination. Care should be taken in lining, or not lining, with paper, sheet tin, etc. Here questions of atmospheric effects often are very important.

Every box should be accompanied by its own list of pieces, and, when possible, by drawings of the parts and the complete machine. This helps the adjusters. It is not a bad idea to send with each machine any particular or peculiar tool that may be found useful or helpful in adjusting the parts.

Next in importance to marking the parts of the machines is the marking of the cases. It should indicate the weight, gross, net (absolutely exact), volume, and port of destination, the latter in large letters, at least two inches long. Marks of identification on each end of a case are of great value. A mark of some kind should surround the heads of nails or screws which should be removed to unpack the machine.

THE MANUFACTURE OF COGNAC BRANDY.*

PURE cognac brandies are distilled from wines produced in the Cognac region, the Charente and Charente Inférieure, and are classed in quality by the district from which the wine comes. There are the "fine champagne," the "petite champagne," "borderies," "fins bois," "bois ordinaires," and "bois communs." The "fine champagne" is grown in a district of France directly to the south of Cognac, comprising half a circle, of which Cognac is the center. The "petite champagne" is grown in a district which would be inclosed between the first half-circle and a larger one parallel to it, at a distance of several miles. The "borderie" is produced in a triangular portion of territory immediately to the north, and slightly to the west of Cognac. Surrounding these areas, but extending a greater distance to the west and to the east, is the region in which is produced the "bois ordinaire," while the "bois commun" is produced between the last-mentioned district and the coast, directly to the west and the southwest. The "bois communs" are also produced on the islands of Ré and Oléron. The wines are distilled under three different auspices. (1) By the "bouilleur de crue," a vineyard owner who distills his own product and sells it to the manufacturer. He usually possesses one still and sometimes two. (2) The "proprietaire," who distills his own product and that of his neighbors, from whom he may buy the wine, or for whom he may distill for remuneration in kind. The "proprietaire" may possess four to eight stills. (3) The "merchant" who owns many important distilleries, wherein are reduced to brandy the wines from his own vineyards and purchased wines. When the wine is bought, the producer is paid in accordance with the degree of alcohol contained. The merchant may have sixteen or even twenty stills in each of his establishments, with a capacity for reducing 40,000 to 50,000 hectolitres (880,000 to 1,100,000 gallons) of wine into brandy during the season.

The methods of distillation vary greatly with the kind of wine, the district, and the person who has charge of the distillery. The United States Consul at La Rochelle says that, as a rule, all Cognac wines are distilled with the lees. The stills employed in the champagne district are usually simple pot stills, with or without "chauffe-vin." The simple still consists of the "chaudière," or boiler, the "chapiteau" which connects the boiler with the third part, and the condenser with its serpentines. The "chauffe-vin" is supposed to be an improvement on the simple still, by which several hours may be saved on each operation. It consists of a reservoir connected with the boiler, through which passes the pipe of the "chapiteau" containing the hot vapors of the wine, which warm the wine to a degree just under that necessary to produce vapors in sufficient quantity to be condensed. Consequently, when the boiler is emptied it can be refilled at once with wine at a temperature high enough to begin to give off vapors at once when over a fire. The boiler is filled with wine by means of a pump, if the still has no "chauffe-vin," and from the "chauffe-vin," if having one. The boilers contain usually about 500 litres (110 gallons) and the liquid is evaporated by means of a mild heat, which is continued until the alcoholometer indicates that the distillate contains no alcohol. At this time it is found that from one-fourth to one-third quantity of wine has passed through the condenser and this distillate is called "brouillis."

In the small distilleries, a still is filled three times before enough brouillis is obtained to commence its re-distillation. In the larger distilleries the products from three stills are united in a single still, and another or second distillation commences, by which the brouillis is converted into brandy. This is called "la bonne chauffe." The "bonne chauffe" is divided into three or four sections as follows: Five per cent of liquor which leaves the still possesses a highly disagreeable odor, due to excessive quantities of concentrated aldehydes and acetic ethers, of a color often greenish or white, called "la tête," or heading, which is taken into a receptacle and kept apart from that which follows. The quantity may exceed five per cent, depending on the nature or quality of the wine. These headings are later mixed with another brouillis, or with what is called "seconds." This alcoholic heading, in condensing, has washed the interior of the serpentine and has removed some oily matters which remained in the spiral from the preceding distillation. The part of the distillate which follows, known as the "cœur," or heart of the "bonne chauffe," is clear, and consists of from 80 to 85 per cent of alcohol. The "cœur" continues to run into the same receptacle until the alcoholometer indicates that the liquor leaving the still contains 50 per cent, or perhaps 55 per cent, of alcohol, according to the wine. When properly carried on, this process lasts about eight hours, and the liquid contains from 66 to 70 per cent of alcohol. This product is brandy. The distillation, however, is continued until again the alcoholometer registers O alcohol. The product of this third part of the distillation is called "queue," or tailing, and is generally added to the next lot of wine placed in the still. It contains from 20 to 24 per cent of alcohol. Sometimes, however, when the wine is very rich in alcohol, a fourth is produced, which is known as "seconds," and consists of that part of the operation wherein the distillate reduces its strength from 60 to 20 deg. These seconds are usually added to the next brouillis, while the remainder of the alcohol obtained—that is, from 20 deg. to O, which in this case is the tailing—is mixed with the next batch of wine. The seconds require about four hours of distillation, which makes the entire process last about twelve hours. This length of time of course applies to the "bonne chauffe." The quality of the brandy produced may depend very largely on the purity of the copper of which the boiler, "chapiteau," and serpentine are composed, as it has often been remarked that the oily acids attack the metal and bring away in the distillate very perceptible quantities of copper compounds, which are disagreeable to the taste, and are probably dangerous to the health. Length of time taken may also mean much. Wine distilled too rapidly may force its fumes too quickly through the serpentine to be condensed, and consequently some of the elements most volatile may escape. Again, the point where the heart is separated from the tailing during the "bonne chauffe" may influence the taste and quality of the distillate. Certain of the superior alcohols pass earlier in the evaporation and the others later.

There are also what may be described as compound stills. These were invented with the object of producing brandy direct from wine in one operation or distillation. The principle of all these stills is that of a "chauffe-vin" and boiler combined, in such a manner as to obtain the complete condensation of vapors which leave the boiler, thus producing a brouillis, which in its turn is re-distilled. The condensation is generally effected by the "chauffe-vin," and the brouillis is collected in another or secondary boiler, in which is inclosed the larger one. The heat which is furnished by the alcoholic vapors of the boiling wine produces a distillation of the brouillis, the vapors of which in their turn are sent into the serpentine and condensed into brandy. There are very large numbers and varieties of these compound stills, which are used only in the country of the "bois," where wines contain very much less aroma, and have a peculiar taste which is called "terroir," or savoring of the soil. The brandies produced from the bois wines are usually mixed or blended with the highly aromatic brandy of the "champagne" or of the "borderies" districts. Much might be written descriptive of the various compound stills, which, although unchanging in principle, become more and more complicated as distance increases from Cognac, the center of the brandy trade. The most complicated ones are used in the districts of the "bois communs," and especially in the islands of Ré and Oléron. The United States consul gives the following description of the method of distillation as practised at one of the most important distilleries he visited. The boilers were filled twice in twenty-four hours. In the morning, half of the sixteen stills were filled with wine, and had produced by evening the impure alcohol known as the "brouillis" or "flegme." In the evening all the boilers were filled with wine, and the next morning they had produced the brouillis. All of the brouillis collected the evening before, and the morning following, from twenty-four different stills, is divided, and placed in eight of the sixteen stills, and is submitted to a re-distillation or rectification called "doubling." The other stills are filled with wine, as on the morning of the day before, in order to combine the process regularly and without interruption in the same manner during the entire season. By this system each man is charged in the morning with the filling of one boiler with brouillis, and one with wine; in the evening two boilers with wine. This idea is the direct result of the quantity of brouillis produced by the distillation of wine, i, e., one-third, so that these boilers must be filled with wine and distilled by each man in order to have sufficient brouillis to fill a single boiler and commence its rectification. Each time a still is filled and each time its product is obtained, whether brouillis or brandy, a declaration is made upon a register which is kept continually at the disposition of the government régie. Each barrel of wine before it goes to the still is numbered, and the still into which it goes must be known; its degree of alcohol is also inscribed in duplicate on a register, one copy of which is placed in a box of which only the officials of the régie have the key; the other copy remains on the register. The amount of brandy produced from that particular barrel of wine must be in proportion to its alcoholic strength, and a register of the quantity obtained in brouillis is kept in the same manner as for the wine. When the brouillis in its turn is distilled, a corresponding record is kept of it, and of the brandy which it produces. The products are placed in casks, each of which is numbered, and the quantity and strength of alcohol therein is also indicated on the barrel. This alcohol cannot be removed from the premises, neither can any alcohol be brought to the premises or carried from one portion of a town or city to another without a permit from the régie, of which permits careful records are kept. The permits indicate by their color, white or pink, whether the alcohol represented by them is wine or some other source than wine. It can be readily understood that this system renders the manipulation of alcohol exceedingly difficult to persons who desire to use it and conceal the fact. The residues of the wine which is left in the still after the brouillis has been produced may be used for the manufacture of fraudulent liquors, but at Cognac it has been found recently that it is much more profitable to denature these residues with lime in order to produce tartar salts, which contain from 48 to 52 per cent of pure tartaric acid. Formerly, when the vintages were very small, owing to the ravages of the phylloxera, many irresponsible people added to the wine they distilled rectified spirits produced from beets. The large quantities of wine produced in the last four years make this proceeding practically useless from a financial point of view. It is further rendered exceedingly difficult by the new regulations of the French government represented by the régie.

* Journal of the Society of Arts.

POPULATION OF CHINA.

ESTIMATES of the population of China are varied and generally unreliable. The latest authoritative attempt to get at the actual number of people in the empire has been made by the officials of the imperial maritime customs and published in the report of 1904. The following estimate, furnished by Consul Anderson, covers the treaty port provinces in detail:

Province.	Population.
Fengtien	16,000,000
Chili	29,400,000
Shantung	37,500,000
Szechuan	79,500,000
Hunan	22,000,000
Hupeh	34,000,000
Kiangsi	22,000,000
Anhwei	35,800,000
Kiangsu	21,000,000
Chekiang	11,800,000
Fukien	20,000,000
Kwantung	32,000,000
Kwangsi	8,000,000
Yunnan	8,000,000
Total of other provinces (Shansi, Shensi, Kansu, Honan, Kuichau)	55,000,000
Total population of empire	432,000,000
Total population of treaty ports	7,012,000

It is probable that the figures generally are too large, although it is to be admitted that to assert that such is the case in any particular instance invites controversy, to say the least. The provinces little known to foreigners, Szechuan, Honan, etc., are the uncertain element. So good an authority on Szechuan as A. Hosie estimates the population of that province at 45,000,000, instead of almost 80,000,000 as given in this table. Missionary accounts, however, lean to the larger figure.

THE COMMERCIAL UTILIZATION OF TANTALUM ALLOYS.

A PROGRESSIVE development in the application of tantalum and its alloys with carbon and steel has been made by the firm of Siemens, Halske & Co., of Berlin, who have been recently granted patents for tantalum alloys. This firm claim that the use of these alloys with carbon and steel produce a material almost equal in hardness to the diamond. It is their intention to use these alloys for bearings, cams, eccentrics, rollers, and similar portions of machinery which are subjected to heavy and hard wear.

According to their specification it is stated that tantalum, like steel, possesses the quality of being easily worked and hardened, while at the same time it has great elasticity and resistance to fracture. It can be hardened to any extent, in fact to a point in excess of that of steel and the stones generally employed. Furthermore it is not affected by the ordinary atmospheric influences, and at certain temperatures resists the action of the majority of acids. This is a most important factor in its application to machinery mechanism. To work the metal satisfactorily it is expedient to fuse the metal thoroughly previously. This can be best carried out *in vacuo* with the electric current, while the fusing process frees it from impurities and renders it perfectly homogeneous.

After melting it can be readily worked in any known mechanical manner; can be hammered, rolled, drawn, filed, and so forth. In mechanical working, if the metal is impregnated with a small percentage of carbon or other hardening medium it readily assumes a degree of hardness that renders it impossible to work it further, unless it is again softened by careful reheating or annealing.

In annealing great care must be exercised to see that the temperature does not rise too high, otherwise the metal is most easily attacked by the oxygen of the atmosphere. Yet even when in the form of finely-drawn wire the metal can be safely heated in the open air to a dull red heat without its quality being impaired. Under these circumstances the coloration of the metal resembles tempered steel. In view of the great care requisite in heating it is preferable to carry out the heating indirectly. This can be accomplished by heating large drums or plates to the temperature to which it is desired to heat the tantalum, and then to bring the latter into contact with these heated surfaces.

The metal can be easily hardened to any degree and for this purpose a wide variety of mediums can be employed. Carbon in particular imparts a great degree of hardness to the metal, since it acts upon it

as if it were steel. Oxygen, hydrogen, boron, silicon, aluminium, tin, and titanium can all be used with perfect satisfaction. Very small quantities of these hardening constituents are requisite to achieve the required end, the proportion in the case of carbon being only one per cent. If too great a proportion of the hardening medium is used the tantalum becomes brittle and unworkable. In fact, so important is the addition of the hardening material, that the permissible quantity of the substance to be employed must be determined in each separate case in accordance with the particular conditions and character pertaining to the hardening medium selected.

[Concluded from SUPPLEMENT No. 1547, page 24784.]

REINFORCED CONCRETE.

REINFORCED concrete has been used with success for vaulted ceilings in churches and other public buildings, and for roofs of various forms. Fig. 18 shows a very slightly arched Eggert roof; Figs. 19 and 20 a Hennebique mansard roof built of rafters and beams as in the usual frame or iron construction. The shell of the roof is also of reinforced concrete, to which the ornamental slate covering is nailed. Pitched roofs are also made of concrete.

FIG. 18.—EGGERT ROOF.

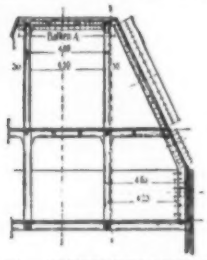


FIG. 19.—HENNEBIQUE ROOF.

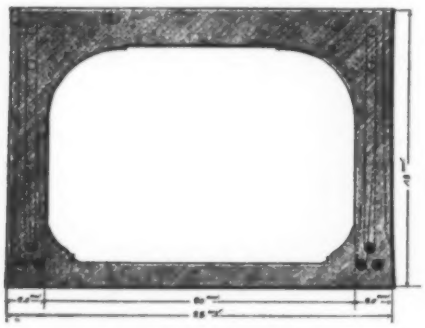


FIG. 22.—SIEGWART BEAM.

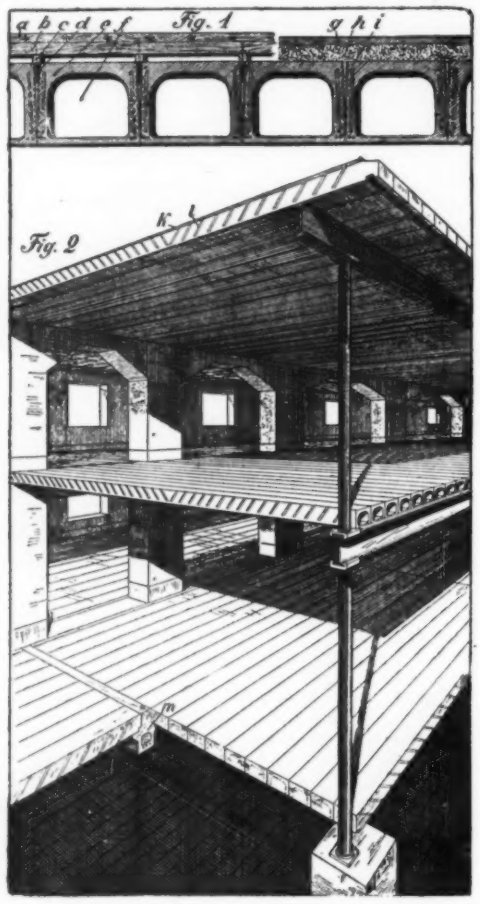


FIG. 25.—SIEGWART FLOORS.

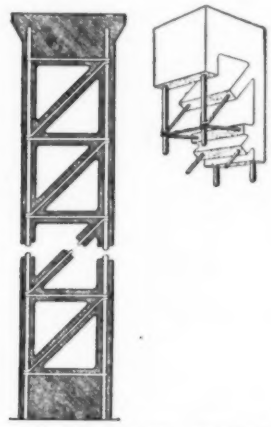


FIG. 27.—VISINTINI COLUMN.

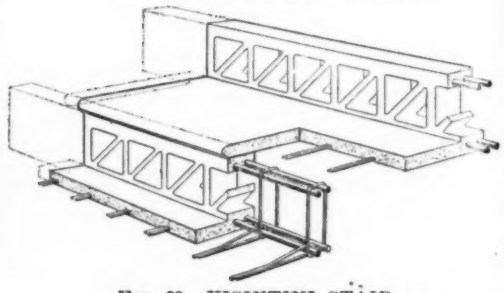


FIG. 28.—VISINTINI STAIR.

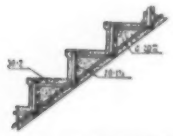


FIG. 21.—REINFORCED CONCRETE STAIRS.

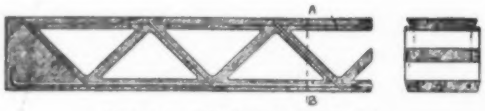


FIG. 26.—VISINTINI BEAM.

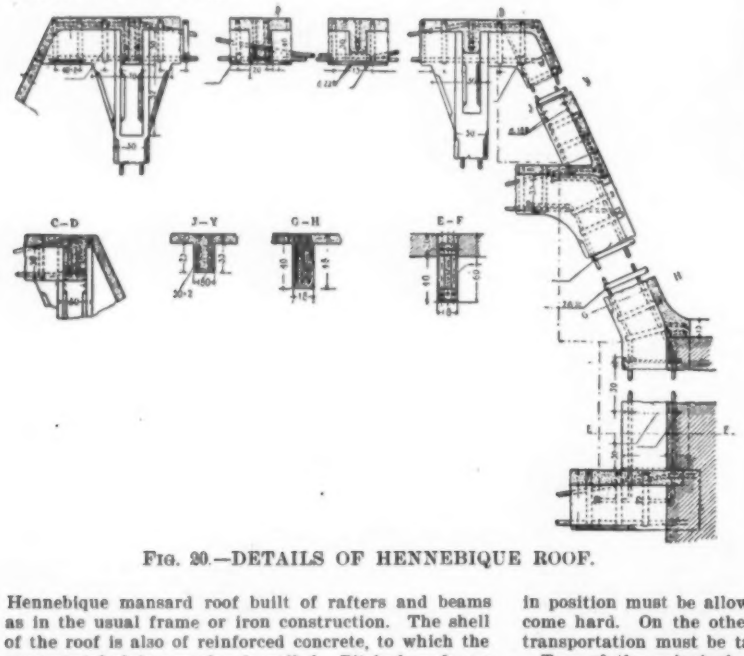


FIG. 20.—DETAILS OF HENNEBIQUE ROOF.

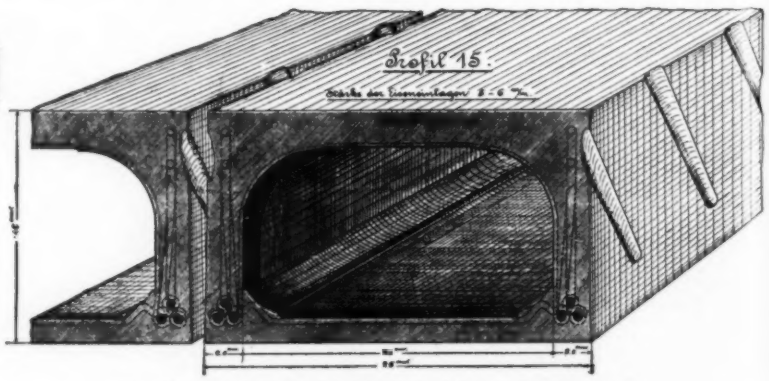


FIG. 23.—SIEGWART BEAMS JOINED LATERALLY.

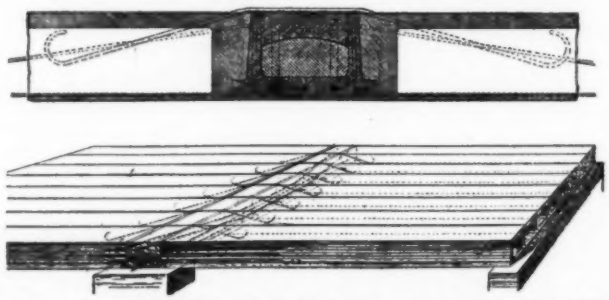


FIG. 24.—ATTACHMENT OF SIEGWART BEAMS TO SUPPORTS.

Walls, balconies, and bay windows need no special description, as their construction is similar to that of floors and beams.

A complete flight of stairs is often molded in one piece (Fig. 21). A more remarkable construction is a spiral staircase formed of a single sheet of reinforced concrete, with steps of marble.

In the foregoing we have supposed all the operations to be carried out at the building site, a method which requires an extensive and expensive equipment. It is possible, however, to have simple elements like beams and columns molded in factories and delivered at the building in a finished and hardened condition. The latter method has the advantage of cheapness, not only because the equipment above mentioned is dispensed with, but also because the combination of the finished simple parts requires less skilled labor than their manufacture, and that of more complex ones, upon the spot. A further advantage is that the floors, for example, may be used at once, while floors molded in position must be allowed a considerable time to become hard. On the other hand, the increased cost of transportation must be taken into account.

Two of the principal systems of construction used in these portable elements are the Siegwart and the Visintini. The former is confined to beams, which are reinforced in much the same manner as Hennebique beams, but are hollow, or tubular. Fig. 22 shows a cross section of a Siegwart beam 7 x 10 inches with lateral walls one inch thick. For floors, etc., the beams are cemented together laterally, adhesion being increased by the oblique channels in the sides (Fig. 23), which also receive the hooked iron rods by which the beams are secured to their supports (Fig. 24). The general construction of Siegwart floors is shown in Fig. 25.

The Visintini beams are also hollow but not tubular, as the partitions between the air spaces run transversely (Fig. 26). Columns and stairs are also made on the Visintini system (Figs. 27 and 28). The construction of buildings entirely, or almost entirely, of reinforced concrete is less common in Germany than in some other countries, but the section of the new Volkstheater in Munich (Fig. 29), in which the concrete parts are indicated by heavy lines, illustrates the bold and extensive use which is now being made of this material, even there.

The construction of factories presents no special difficulties, but peculiar expedients are needed in building coal depots, grain elevators, etc., of reinforced concrete. The municipal grain elevator in Strassburg, in which both the Monier and Hennebique system are employed, is illustrated in Figs. 30, 31, and 32.

In America numerous factory chimneys have been built of concrete reinforced according to the Monier system. Fig. 33 shows vertical and horizontal sections of the chimney of an electrical plant at Los Angeles.

Reinforced concrete has been used for water tanks very extensively and with great success. In France thousands of tanks, some of them of a capacity of 4,000 cubic meters, or more than a million gallons, have been constructed on the Monier and Hennebique systems. Fig. 34 shows an elevated tank in Italy.

Gas and oil tanks and water pipes have also been made of reinforced concrete. Fig. 35 gives a cross-section of a Monier pipe which conveys water, for power, to a French electrical plant. It rests on a bed of plain concrete, is more than a mile long and sus-

tains an internal pressure of about two atmospheres.

In bridge building reinforced concrete has long been used, at first exclusively in the form of Monier arches. A fine example is the high bridge at Zell, Austria, with a span of 145 feet. Fig. 36 shows a foot bridge of 100 feet span in which the concrete arch is reinforced by I-beams, while the San Francisco bridge illustrated in Figs. 37 and 38, has a riveted steel skeleton. In Hennebique arched bridges the sides of the arches are (Fig. 41) the sea wall proper is only ten inches thick, but it is strengthened in the manner indicated in the diagram and by earth filled in between the piles. The whole structure consists of concrete reinforced on the Hennebique system. Its cheapness, in comparison with a masonry wall, is obvious.

For foundations of breakwaters, where piles cannot be used, great boxes are built of reinforced concrete and towed, empty, to the place of operations, where

A framework was constructed of iron rods, about a foot apart, and connected by horizontal rods. This skeleton was then clothed temporarily, inside and out, with wooden planks, between which concrete was rammed. A spiral stair of reinforced concrete leads to the lantern. The lighthouse, exclusive of its concrete foundation, weighs less than 400 tons and cost less than $6,000.

The foregoing enumeration of the uses of reinforced

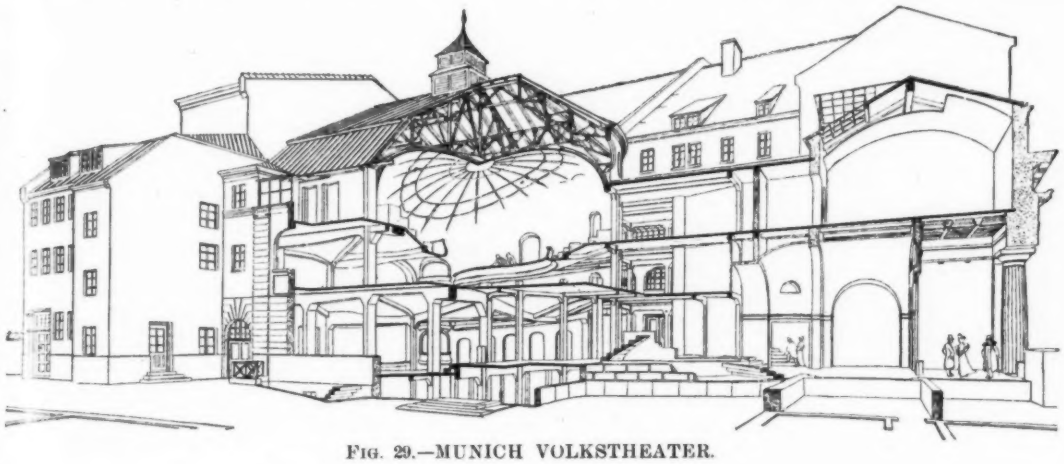


FIG. 29.—MUNICH VOLKSTHEATER.

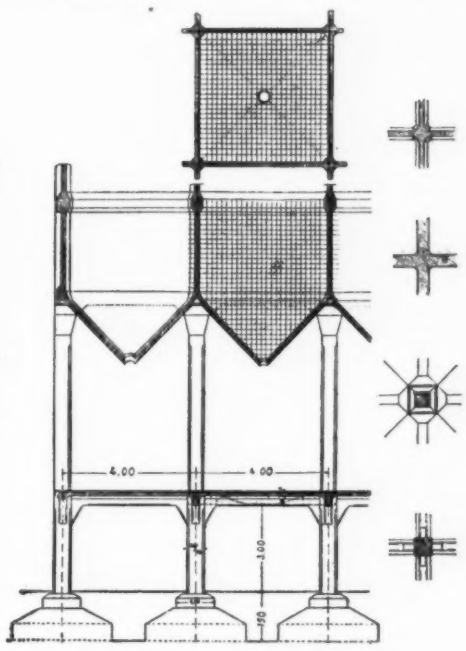


FIG. 32.—DETAIL OF FIG. 31.

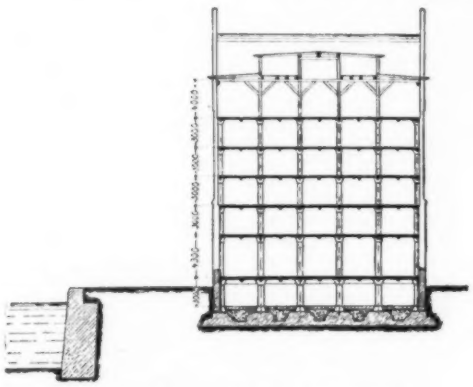


FIG. 30.—STRASSBURG ELEVATOR. STOREHOUSE.

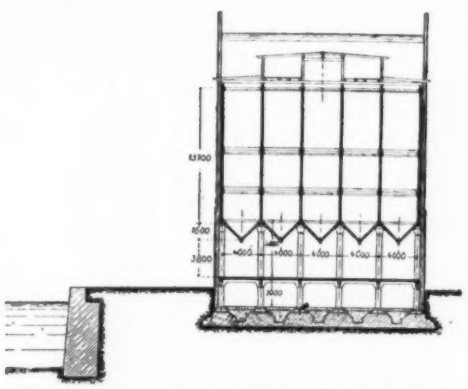


FIG. 31.—STRASSBURG ELEVATOR. ELEVATED BINS.

FIG. 34.—ELEVATED WATER TANK.

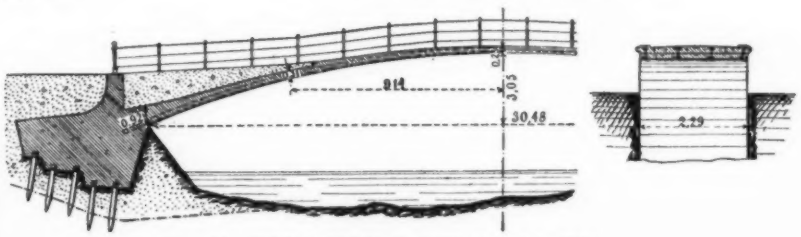


FIG. 36.—FOOT BRIDGE, MELAN SYSTEM.

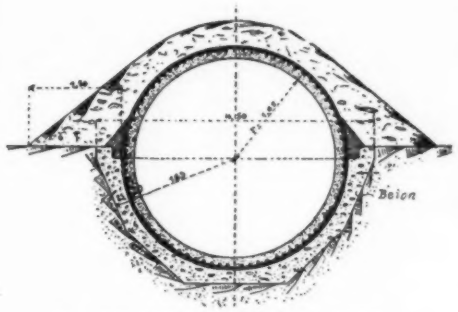


FIG. 35.—MONIER WATER PIPE.

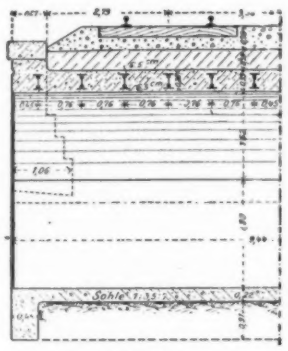


FIG. 38.

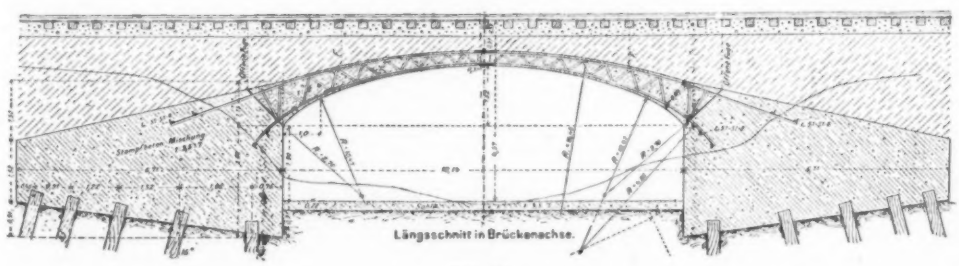


FIG. 37.

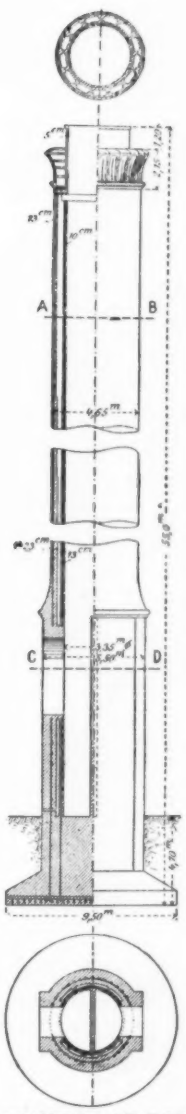


FIG. 33.—MONIER CHIMNEY AT LOS ANGELES.

resolved into series of vertical ribs and some of them imitate pure steel construction. A small flat bridge is shown in Fig. 39, and a larger one in Fig. 40. Even in iron and stone bridges reinforced concrete construction is much used for driveways and paths.

The employment of reinforced concrete in dams and similar works has already become very extensive. Especial interest attaches to the great concrete sea walls at Nantes and Southampton. In the latter they are filled with plain concrete and sunk. Concrete blocks weighing 3,000 tons each were sunk in this way in the harbor of Bruges.

A remarkable application of reinforced concrete construction was made in the lighthouse at Nikolajeff, near the Black Sea, and connected with it by a ship canal (Figs. 42 and 43). Though the tower is 132 feet in height its concrete walls are only 8 inches thick at the base and less than half as thick at the top.

concrete is far from complete. The new construction has been applied with success to various other purposes, such as the protection of shores from erosion by waves and tides, the lining of mine shafts and galleries, the making of building foundations in soft ground, etc.

In general building it can never wholly supersede masonry, steel, and frame construction, for the obvious reason that the designing, calculation, and erection of

a concrete structure demands great technical knowledge and most careful and concientious supervision, as incompetence and negligence may create or overlook defects, which are not easily detected in the finished building and may lead to ultimate disaster.

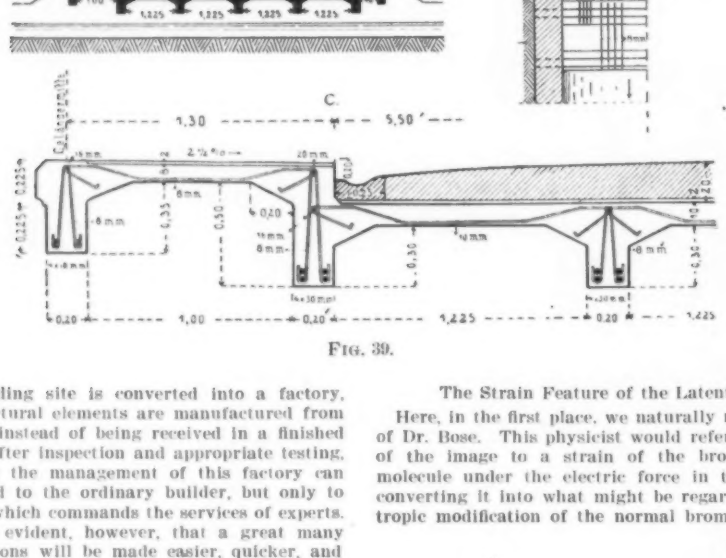


FIG. 39.

When a building site is converted into a factory, where the structural elements are manufactured from raw materials, instead of being received in a finished condition and after inspection and appropriate testing, it is clear that the management of this factory can not be intrusted to the ordinary builder, but only to a reliable firm which commands the services of experts.

It is equally evident, however, that a great many building operations will be made easier, quicker, and cheaper by the use of reinforced concrete.—From the German of Max Buchwald, in Prometheus.

THE LATENT IMAGE.*

Photo-sensitiveness at Low Temperatures.

I would first draw your attention to Sir James Dewar's remarkable result that the photographic plate

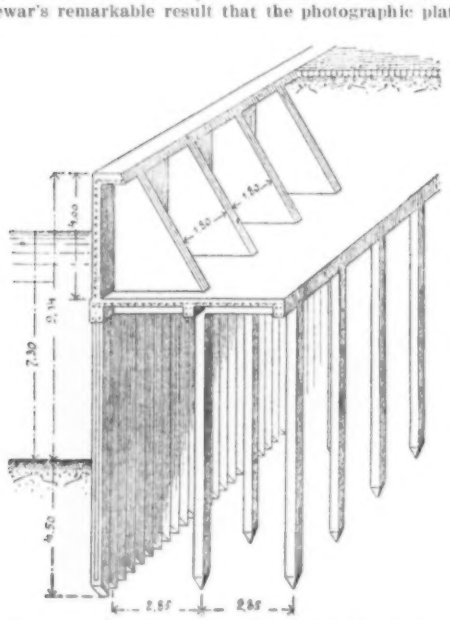


FIG. 41.—SEA WALL AT SOUTHAMPTON. HENNEBIQUE SYSTEM.

retains considerable power of forming the latent image at temperatures approaching the absolute zero. A result which, as I submit, compels us to regard the fundamental effects progressing in the film under the stimulus of light undulations as other than those of a purely chemical nature. But few, if any, instances of chemical combination or decomposition are known at so low a temperature. Purely chemical actions cease, indeed, at far higher temperatures, fluorine being among the few bodies which still show chemical activity at the comparatively elevated temperature of 180 deg. C. In short, this result of Sir James Dewar's suggests that we must seek for the foundations of photographic action in some physical or intra-atomic effect, which, as in the case of radio-activity or fluorescence, is not restricted to intervals of temperature over which active molecular *vis viva* prevails. It compels us to regard with doubt the rôle of oxidation or other chemical action as essential, but rather points to the view that such effects must be secondary or subsidiary. We feel, in a word, that we must turn for guidance to some purely photo-physical effect.

The Strain Feature of the Latent Image.

Here, in the first place, we naturally recall the views of Dr. Bose. This physicist would refer the formation of the image to a strain of the bromide of silver molecule under the electric force in the light wave, converting it into what might be regarded as an allotropic modification of the normal bromide which subsequently responds specially to the attack of the developer. The function of the sensitizer, according to this view, is to retard the recovery from strain. Bose obtained many suggestive parallels between the strain phenomena he was able to observe in silver and other substances under electro-magnetic radiation, and the behavior of the photographic plate when subjected to long and continued exposure to light.

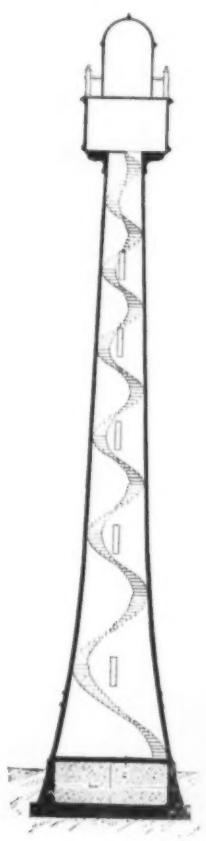


FIG. 42.—SECTION OF THE NIKOLAJEFF LIGHTHOUSE.

FIG. 43.—ELEVATION OF THE NIKOLAJEFF LIGHTHOUSE.

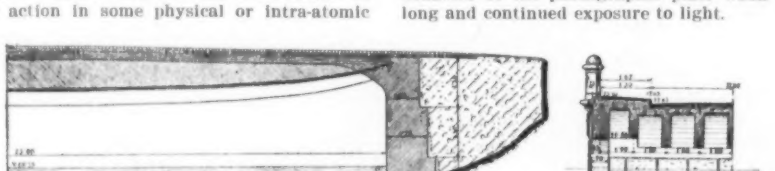


FIG. 40.—MOELLER BRIDGE.

This theory, whatever it may have to recommend it, can hardly be regarded as offering a fundamental explanation. In the first place, we are left in the dark as to what the strain may be. It may mean many and various things. We know nothing as to the inner mechanism of its effects upon subsequent chemical actions; or, at least, we cannot correlate it with what is known of the physics of chemical activity. Finally, as will be seen later, it is hardly adequate to account for the varying degrees of stability which may apparently characterize the latent image. Still, there is much in Dr. Bose's work deserving of careful consideration. He has by no means exhausted the line of investigation he has originated.

A Photo-electric Hypothesis.

Another theory has doubtless been in the minds of many. I have said we must seek guidance in some photo-physical phenomenon. There is one such which pre-eminently connects light and chemical phenomena through the intermediary of the effects of the former upon a component part of the atom. I refer to the phenomenon of photo-electricity. It was ascertained by Hertz and his immediate successors that light has a remarkable power of discharging negative electrification from the surface of bodies—especially from certain substances. For long no explanation of the cause of this appeared. But the electron—the ubiquitous electron—is now known with considerable certainty to be responsible. The effect of the electric force in the light-wave is to direct or assist the electrons contained in the substance to escape from the surface of the body. Each electron carries away a very small charge of negative electrification. If, then, a body is originally charged negatively, it will be gradually discharged by this convective process. If it is not charged to start with, the electrons will still be liberated at the surface of the body, and this will acquire a positive charge. If the body is positively charged at first, we cannot discharge it by illumination.

Electrons and Ionization.

It would be superfluous for me to speak here of the nature of electrons, or of the various modes in which their presence may be detected. Suffice it to say in further connection with the Hertz effect, that when projected among gaseous molecules, the electron soon attaches itself to one of these. In other words, it ionizes a molecule of the gas, or confers its electric charge upon it. The gaseous molecule may even be itself disrupted by impact of the electron, if this is moving fast enough, and left bereft of an electron. We must note here that such ionization must be regarded as conferring potential chemical properties upon the molecules of the gas and upon the substance whence the electrons are derived. Similar ionization under electric forces enters, as we now believe, into all the chemical effects progressing in the galvanic cell, and, indeed, generally in ionized solutants.

I have here a simple experiment which will at once illustrate the principles I wish to remind you of. A clean aluminium plate, carefully insulated by a sulphur support, is faced by a sheet of copper wire gauze placed a couple of centimeters away from it. The gauze is maintained at a high positive potential by this dry pile. A sensitive gold-leaf electroscope is attached to the aluminium plate, and its image thrown upon the screen. I now turn the light from this arc lamp upon the wire gauze, through which it in part passes and shines upon the aluminium plate. The electroscope at once charges up rapidly. There is a liberation of negative electrons at the surface of the aluminium; these, under the attraction of the positive body, are rapidly removed as ions, and the electroscope charges up positively.

Again, if I simply electrify negatively this aluminium plate, so that the leaves of the attached electroscope diverge widely, and now expose it to the rays from the arc lamp, the charge, as you see, is very rapidly dissipated. With positive electrification of the aluminium there is no effect attendant on the illumination.

The Electron in Photographic Action.

Thus from the work of Hertz and his successors we know that light, and more generally what we call actinic light, is an effective means of freeing the electron from certain substances. In short, our photographic agent—light—has the power of evoking from certain substances the electron which is so potent a factor in most, if not all, chemical effects. I have not time here to refer to the work of Elster and Geitel, whereby they have shown that this action is to be traced to the electric force in the light wave, but must turn to the probable bearing of this phenomenon on the familiar facts of photography. I assume that the experiment I have shown you is the most fundamental photographic experiment which it is now in our power to make.

We must first ask from what substances light can liberate the electron. There are many; metals, as well as non-metals and liquids. It is a very general phenomenon, and must operate widely throughout nature. But what chiefly concerns the present consideration is the fact that the haloid salts of silver are vigorously photo-electric, and possess, according to Schmidt, an activity in the descending order: bromide, chloride, iodide. This is, in other words, their order of activity as ionizers (under the proper conditions) when exposed to ultra-violet light. Photographers will recognize that this is also the order of their photographic sensitiveness.

Photo-electric Activity and Light Absorption.

Another class of bodies also concerns our subject—the special sensitizers used by the photographer to modify the special distribution of sensibility of the haloid salts—e.g., eosine, fuchsine, cyanine. These again are electron producers under light stimulus. Now, it has been shown by Stoletow, Hallwachs, and Elster and Geitel that there is an intimate connection between photo-electric activity and the absorption of

* Prof. J. Joly's address delivered on July 10 at Dublin, at the twentieth meeting of the Photographic Convention, for which we are indebted to the British Journal of Photography.

light by the substance; and, indeed, that the particular wave lengths absorbed by the substance are those which are effective in liberating the electrons. Thus we have strong reasons for believing that the vigorous photo-electric activity displayed by the special sensitizers must be dependent upon their color absorption. You will recognize that this is just the connection between their photographic effects and their behavior toward light.

Photo-electrics and Temperature.

There is yet another suggestive parallel. I referred to the observation of Sir James Dewar as to the continued sensitiveness of the photographic film at the lowest attained extremes of temperature, and drew the inference that the fundamental photographic action must be of intra-atomic nature, and not dependent upon the *vis viva* of the molecule or atom. In then seeking the origin of photographic action in photo-electric phenomena, we naturally ask: Are these latter phenomena also traceable down to low temperatures? If they are, we are entitled to look upon this fact as a qualifying characteristic or as another link in the chain of evidence connecting photographic with photo-electric activity.

I have quite recently, with the aid of liquid air (kindly supplied to me by Mr. Moss, and made in the laboratory of this society), tested the photo-sensibility of aluminium, and also of silver bromide, down to temperatures approaching that of the liquid air. The mode of observation is essentially that of Schmidt—what he terms his static method. The substance undergoing observation is, however, contained at the bottom of a thin copper tube, which is immersed to a depth of about 10 centimeters in liquid air. The tube is closed above by a paraffin stopper, which carries a thin quartz window as well as the sulphur tubes through which the connections pass. The air within is very carefully dried by phosphorous pentoxide before the experiment. It was found that a vigorous photo-electric effect continued in the case of the clean aluminium. In the case of the silver bromide, a distinct photo-electric effect was still observed. I have not had leisure to make, as yet, any trustworthy estimate of the percentage effect at this temperature in the case of either substance. Nor have I determined the temperature accurately. The latter may be taken roughly as about —150 deg. C. Sir James Dewar's actual measurements afforded 20 per cent of the normal photographic effect at —180 deg. C., and 10 per cent at the temperature of —252.5 deg. C.

The Basis of a Physical Theory.

With this much to go upon, and the additional fact that the electronic discharge—as from the X-ray tube or from radium—generates the latent image, I think we are fully entitled to suggest as a legitimate lead to experiment the hypothesis that the beginnings of photographic action involve an electronic discharge from the light-sensitive molecule. In other words, that the latent image is built up of ionized atoms, or molecules, the result of the photo-electric effect upon the illuminated silver haloid, and upon these ionized atoms the chemical effects of the developer are subsequently directed. It may be that the liberated electrons ionize molecules not directly affected, or it may be that in their liberation they disrupt complex molecules built up in the ripening of the emulsion. With the amount we have to go upon we cannot venture to particularize. It will be said that such an action must be in part of the nature of a chemical effect. This must be admitted, and in so far as the rearrangement of molecular fabrics is involved the result will doubtless be controlled by temperature conditions. The facts observed by Sir James Dewar support this. But there is involved a fundamental process—the liberation of the electron by the electric force in the light-wave, which is a physical effect, and which, upon the hypothesis of its reality as a factor in forming the latent image, appears to completely explain the outstanding photographic sensitiveness of the film at temperatures far below those at which chemical actions in general cease.

Again, we may assume that the electron-producing power of the special sensitizer or dye for the particular ray it absorbs is responsible, or responsible in part, for the special sensitiveness it confers upon the film. Sir William Abney has shown that these sensitizers are active, even if laid on as a varnish on the sensitive surface, and are removed before development. It must be remembered that at fairly high temperatures these sensitizers lose their influence on the film. (See a paper by me read before the convention in 1894.)

An Explanation of Recurrent Reversal.

It appears to me that on these views the curious phenomenon of recurrent reversals does not present a problem hopeless of explanation; for the process of photo-ionization constituting the latent image, where the ion is probably not immediately neutralized by chemical combination, presents features akin to the charging of a capacity—say a Leyden jar. There may be a rising potential between the groups of ions till ultimately a point is attained when there is a spontaneous neutralization. I may observe that the phenomena of reversal appear to indicate that the latent change upon the silver bromide molecule, whatever be its nature, is one of gradually increasing intensity, and finally attains a maximum when a return to the original condition occurs. The maximum is the point of most intense developable image. It is probable that the sensitizer—in this case the gelatine in which the bromide of silver is immersed—plays a part in the conditions of stability which are involved.

Degrees of Stability in Latent Images.

Of great interest in all our considerations and theories is the recent work of Prof. Woods on photographic reversal. The result of this work is—as I take it—to show that the stability of the latent image may be very various, according to the mode of its formation. Thus it appears that the sort of latent effect which is produced by pressure or friction is the least stable of any. This may be reversed or wiped out by the application of any other known form of photographic stimulus. Thus an exposure to X-rays will obliterate it, or a very brief exposure to light. The latent image arising from X-rays is next in order of increasing stability. Light-action will remove this. Third in order is a very brief light-shock, or sudden flash. This cannot be reversed by any of the foregoing modes of stimulation, but a long-continued undulatory stimulus, as from a lamp, will reverse it. Last, and most stable of all, is the gradually built-up configuration due to long-continued light exposure. This can only be reversed by overdoing it, according to the known facts of recurrent reversal. Prof. Woods takes occasion to remark that these phenomena are in bad agreement with the strain theory of Dr. Bose. We have, in fact, but the one resource—the allotropic modification of the haloid—whereby to explain all these orders of stability. It appears to me that the elasticity of the electronic theory is greater. The state of the ionized system may be very various according as it arises from continued rhythmic effects or from unorganized shocks. The ionization due to X-rays or to friction will probably be quite unorganized; that due to light more or less stable according to the gradual and gentle nature of the forces at work. I think we are entitled to conclude that on the whole there is nothing in Prof. Woods's beautiful experiments opposed to the photo-electric origin of photographic effects, but that they rather fall in with what might be anticipated.

When we look for further support to the views I have laid before you, we are confronted with many difficulties. I have not, as yet, detected any electronic discharge from the film under light stimulus. This may be due to my defective experiments, or to a fact noted by Elster and Geitel concerning the photo-electric properties of gelatine. They obtained a vigorous effect from Balmain's luminous paint, but when this was mixed in gelatine there was no external effect. Schmidt's results as to the continuance of photo-electric activity when bodies in general are dissolved in each other lead us to believe that an actual conservative property of the medium and not an effect of this on the luminous paint is here involved. This conservative effect of the gelatine may be concerned with its efficacy as a sensitizer.

In the views I have laid before you I have endeavored to show that the recent addition to our knowledge of the electron as an entity taking part in many physical and chemical effects may be availed of, and should be kept in sight in seeking an explanation of the mode of origin of the latent image.

HISTORIC WALLINGFORD.*

WALLINGFORD is a place of very considerable interest, although it can show no very striking relics of its former importance. The earthworks are its most characteristic feature. I am not going to talk about Calleva of the Atrebates. A strong conviction that it is Wallingford prevails among those who live within the earthworks; but I have not that advantage, and therefore I can give you no name for Wallingford older than the Saxon one which it now bears. But that name, I think, embodies an important fact, for I am not aware that its accepted meaning is disputed. Wallingford is, no doubt, the ford of the Wallingas, the sons of the Walla or Welshman. And when the Saxons gave it this designation, it must have been in view of the fact that this was the crossing of a very important highway of the Britons. There were plenty of fords above and below, but this was emphatically the Wallingas Ford. There is sufficient evidence that the place was occupied by the Romans. The streets at the present day show the Roman plan, though the paucity of Roman relics might alone prove that it was not a station of importance. Perhaps I get upon disputable ground if I mention the opinion that Wallingford is closely connected with the opening scenes of Aulus Plautius's invasion, but at any rate strong arguments are alleged for the belief that the invaders landed in the southwest of our island and came up the Severn and down the Thames, that they gained their great victory over Caractacus above Dorchester, that their camp for the protection of the Dobuni was planted on Sinodun Hill across the river, that the Catuvellauni fled down the river on this northern side, and crossed at Wallingford in the hope of escaping homeward along the Chiltern Hills, and that the Romans came upon them unexpectedly on the northern side of the river and cut off their retreat at Crowmarsh. If all this is so, it would seem to follow that a garrison must have been stationed at this ford from the very beginning of the Roman occupation. When we come to the Saxon conquest we find that at the middle of the sixth century the West Saxons had gained victories on the Wiltshire Downs and at Wimbledon, and thus had secured the whole district south of the Thames. The chronicle goes on to tell that in 571 they advanced northward and gained a victory at Bedford which put all the district west of the Chilterns into their power, Bensington, opposite Wallingford, being the southernmost of the four towns that are named. It is assumed by historians that they must have crossed the river at Wallingford.

The next great event is the conversion of the English to Christianity, and in the history of that event the district close beside Wallingford is in some respects the most conspicuous in England. Augustine had come to Canterbury nearly forty years before, and the Kentish men had become Christians, but the new faith had made but little progress beyond them. St. Berin or Birinus came in 635, and soon after his landing he penetrated as far as Dorchester. King Cynegils of Wessex brought his daughter, Cyneburga, to be married here to Oswald, the Christian king of Northumbria, and under the influence of the missionary and the Northumbrian king the old Saxon warrior-king accepted the faith and his people followed him. The supreme importance of the event lies in the fact that Cynegils was the head of that royal house which was to become at last the royal house of England, and the beautiful abbey marks the spot where the king and his sons were baptized.

Returning to the subject of the Saxon conquest, you will not wish me to go into a detailed account of the fluctuation of the border line of the West Saxon and the Mercian kingdoms as it affected the Wallingford district. It will be sufficient to recall the fact that as early as 661 (the chronicler tells us) "Wulfhere, the son of Penda, laid the country waste as far as Ashdown," i.e., the line of the Berkshire Downs; but this was evidently no more than a temporary raid. It was in 777 that Offa defeated Cynewulf of Wessex at Bensington, and the whole district as far as the downs was finally added to the Mercian kingdom, and remained so for fifty years. A century later, in 871, the Danes made their first great incursion into the center of the land, and Alfred made his first appearance in our history. He, with his brother, King Ethelred, fought the Danes and defeated them utterly at Ashdown. The best modern historians are agreed, I believe, that the scene of the battle was above Cholsey, the whole line of the downs being then known as Ashdown.

We read the name of Wallingford for the first time on the coins of Athelstan, the grandson of Alfred, who reigned from 925 to 941, and the royal mint continued here till Henry III.'s reign. But the first actual mention of the town in history is in 1006, at the time of the Danish invasion under Sweyn. Some eleventh-century editions of the Chronicle tell us that the Danes at midwinter "went through Hampshire into Berkshire to Reading, and there they did their old wont; they lighted their war beacons wherever they went; then went they to Wealingaford and they burnt it all."

From the Domesday Survey we learn that in the time of Edward the Confessor fourteen acres at Wallingford belonged to the king, and were occupied by a company of his house-carles. It would appear that these house-carles were under the command of the Saxon thegn, Wigod, a cousin of the king, holding the high office of cup-bearer. It is here that Wallingford comes into the forefront of English history. Wigod supported the claims of William the Norman to the throne, and when the Conqueror, after the battle of Hastings, marched toward London and found that he would be opposed at Southwark, he turned aside to avoid another battle and came to Wallingford. Here he received Archbishop Stigand and the other nobles who came to do homage, and he remained here for the marriage of Wigod's daughter and heiress with Robert d'Oyley, one of his Norman chieftains, and he directed him to build a strong castle, which was completed in 1071, eight dwellings being destroyed to make room for it. For the history of the castle, it is not possible in a brief space to do more than mention the leading events: the marriage of d'Oyley's daughter and heiress, Matilda, with Milo Crispin, one of the richest landowners of the Domesday Survey; her second husband, Brient Fitzcourt, defending the castle for the Empress Maud, the daughter of King Henry Beauclerc; the famous escape of the empress from Oxford Castle when she came hither from Abingdon after her flight along the frozen river; the memorable treaty of Wallingford, by which the crown was secured to Stephen for his life, and Henry Plantagenet, the empress's son, was to succeed him, and so the civil war was ended; the first Parliament of Henry II. held here in 1155, when he granted the town its charter; the seizure of the castle by Prince John, one of his first acts of treachery against his brother, Richard Cœur de Lion, who had left it in the custody of the Archbishop of Rouen and had gone to the Holy Land; the magnificent state maintained here by Richard, king of the Romans, the brother of Henry III., who built the great hall of the castle, and also built the oldest parts which remain of Wallingford bridge; then the stirring events of the Barons' wars, when Simon de Montfort seized the castle during the absence of the King of the Romans in Germany; the imprisonment here of the two kings and the royal princes after the defeat of the royal party at Lewes in 1264, and the escape of Prince Edward while he was being conveyed to Kenilworth, followed by his victory over the barons at Evesham; then the tenure of Edmund, Earl of Cornwall, Richard's son, who appears to have refounded the collegiate church of St. Nicholas, of which the ruins survive; the marriage of Earl Edmund's widow with Piers de Gaveston and the prominent part which the castle bore in the miseries of Edward II.'s reign; then happier scenes when it was the favorite home of Edward the Black Prince, and of his widow, Joan of Kent; then the change which made it merely a military fortress and no longer a royal residence; yet royalty occupying it from time to time, as when Isabella de Valois, affianced

* A paper by the Rev. J. E. Field, read before the members of the British Archæological Association.

to Richard II., was protected here during Bolingbroke's invasion, and when the baby King Henry VI. spent much of his childhood here; the marriage of Catherine the queen mother with Owen Tudor, which is said to have been solemnized secretly in a dungeon here where he was a prisoner; the captivity of Queen Margaret of Anjou here under the custody of the Duchess of Suffolk; then, passing over minor events, the defense of the castle for King Charles during a memorable siege which lasted upward of nine weeks, holding out when every other fortress in the central parts of England had yielded, and only the remote Ragland, on the Welsh border, and Pendennis, in Cornwall, remained; then the surrender to Fairfax, July 27, 1646, when provisions had failed and all supply was cut off, and the garrison was allowed to march out as if they were victors with flying colors; lastly, six years later, the demolition of the buildings by order of Parliament, and nothing left but two small fragments of the outer walls. I think this rapid summary is sufficient to show how very prominent a part Wallingford Castle bore for 600 years in the history of England.

Passing on to other subjects, let me mention, as one of special interest, the beautiful ivory seal, now in the British Museum, which was found nearly thirty years ago close to the market place at Wallingford, engraved with the name and effigy of Earl Godwin, and on the reverse with those of Godgytha, the nun. I must remind you that Edward the Confessor had large possessions in Wallingford, that Earl Godwin was his father-in-law, and that Gytha, Godwin's widow, devoted herself after his death to religious work. She is represented here holding a book and raising her hand as if in exhortation. All the facts, taken together, suggest the conclusion that she must have presided over a religious house of women in Wallingford.

I can only attempt to give a few brief notes about the numerous churches. Including all the parish churches and chapels, and others that were not parochial, there were as many as fifteen at the close of the thirteenth century, and all the sites are known. St. Mary the More, at the top of the market place, probably represents the church of the Roman-British town. St. Leonard's, if the arguments of so high an authority as Mr. Park Harrison are sound, is of the tenth century, and a very fine example. St. Martin's, near the central crossing, was also very probably of Saxon date. Domesday Book mentions one church here, belonging to the Bishop's manor of Sonning, but I am not aware of any facts by which it can be identified. Robert d'Oyley, the builder of the castle, is probably responsible for several of the churches also. He founded the one monastic house of the town, the Benedictine priory of the Holy Trinity, a cell of St. Albans, which gave to the abbey more than one of its famous and learned abbots. He probably built St. Peter's, on a tumulus beside the ford, at the east gate—the third of the churches now existing, but rebuilt in the eighteenth century and enlarged this year—and he probably built also the chapel of St. Peter in the West at the west gate, and also All Hallows near the north gate and adjoining to the barbican of the castle. Mile Crispin, his son-in-law, is said to have built the collegiate church of St. Nicholas in the castle.

At the south gate was a church bearing the unusual dedication of St. Rumbold, who was the local saint of Buckingham, and I would hazard the conjecture that it may have been founded by Walter Gifford, the Earl of Buckingham, who owned property at Wallingford in Domesday. Then there was the hospital of St. John Baptist, founded at an early date, and enriched by Simon de Montfort. There was the bridge chapel, called the Mary Grace, probably built by Richard, king of the Romans. There were also three other parish churches, besides the chapel of St. Lucian outside the south gate. But the Black Death of 1349 wrought terrible ravages here, and in the early part of the next century the high road to the west was diverted to enter Berkshire at Abingdon instead of Wallingford, and the effect of these events upon the town is illustrated by the fact that seven of the churches disappear entirely before the end of the fifteenth century. In the sixteenth century the priory, of course, was dissolved; the collegiate church and the hospital went the same way. At the siege in 1643 the bridge chapel and All Hallows Church were destroyed. Three churches still survive.

The bridge is an object of more than ordinary interest. Its twenty arches include four of the massive ribbed arches of the thirteenth century built by Richard, king of the Romans, and several rebuilt with Norman work from the priory church in 1530, and three which were taken out when drawbridges were substituted at the siege and which were rebuilt in brick in 1750, and, lastly, three which were made entirely new when they had been ruined by a flood in 1809, and when the whole length of the bridge was widened.

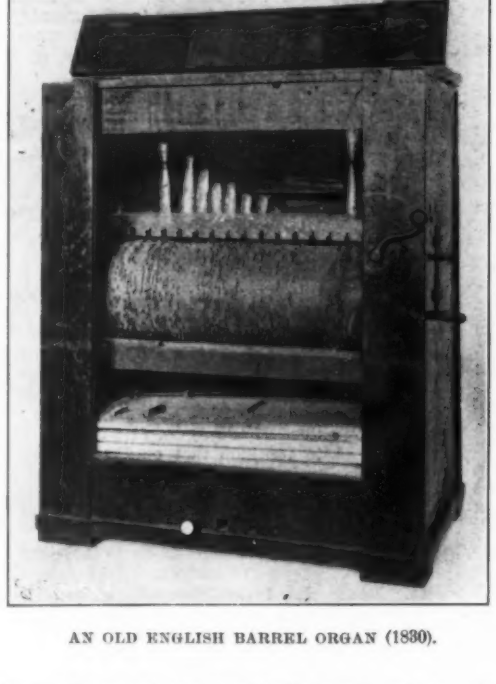
I must do no more than enumerate some famous names that the town can claim as her own: John of Wallingford, the chronicler of the twelfth century, and Richard of Wallingford, the mathematician and astronomer of the fourteenth century, both abbots of St. Albans; Sir William Knollys, constable of the castle, who was created Viscount Wallingford by James I. and Earl of Banbury by Charles I.; and, lastly, Sir William Blackstone, the commentator on the laws of England, in the latter part of the eighteenth century.

I will conclude by mentioning that Wallingford was made a royal borough by King Edward the Confessor; that its charter was granted by King Henry II. in 1155, from which time its mayoralty began, thirty-four years before that of London; and that the question of which is the oldest municipality in the kingdom is disputed between Wallingford and Winchester.

SOME CURIOUS OLD BARREL ORGANS.*

NOT the least interesting members of the admirable Crosby-Brown collection of musical instruments in the Metropolitan Museum of Art, New York city, are some fine specimens of early automatic instruments. Prominent among these is an old barrel piano, which seems to be the progenitor of our modern piano street organ. It is contained in an upright oblong case of walnut, inclosing a cylinder turned by a crank. This crank projects through the case and sets in motion small hammers, which strike the strings. At the same time ten small dancing figures are moved. The instrument in question was made early in the nineteenth century. It stands about three feet high.

Still another interesting specimen, of which we present two views, is a barrel organ having a compass of ten notes. Its mechanism is inclosed in a black case painted with flowers, the outside of the covering being decorated with a painted hunting scene. Three short handles on the left-hand side admit wind into the three registers of metal pipes, namely, stopped middle diapason, octave, and super-octave. A small handle in the front of the case moves a spindle which works a bellows, and, by means of an endless screw, opens the valves. The organ was made in France about 1800 by Charles Denis, Mirecourt, Vosges. Its length is about 1 foot 3 inches.

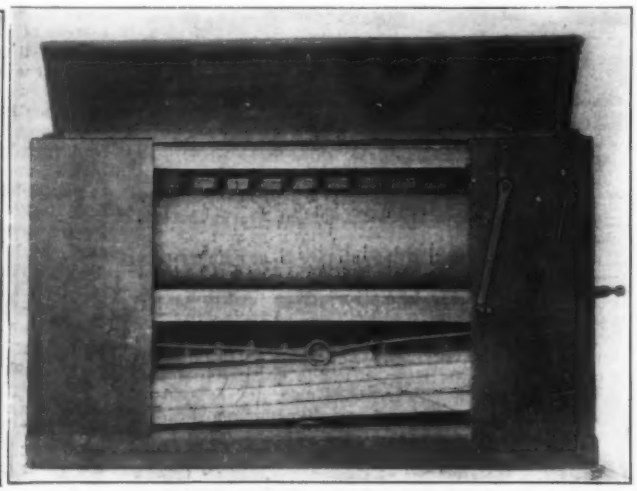


AN OLD ENGLISH BARREL ORGAN (1830).

A CURIOUS BARREL PIANO MADE EARLY IN THE LAST CENTURY.

Somewhat larger than the foregoing is an English barrel organ, made in 1830, having a compass of fourteen notes. Its small upright mahogany case has an ornamental pipe front and contains two rows of metal pipes with two stops in front, a third stop acting on the mechanical motion of the barrel.

A FRENCH BARREL ORGAN OF 1800.



FRENCH BARREL ORGAN MADE IN 1800.

SOME CURIOUS OLD BARREL ORGANS.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE ART OF MAKING A PLAIN BUSINESSLIKE STATEMENT.

By PROF. W. RIPPER.

THERE are many qualities necessary to success in modern business life; but there is none of more importance to a man holding a position of responsibility than the power to make a plain, straightforward, businesslike statement, either by speech or in writing. The necessity for such a power arises continually in the every-day practice of business, and the higher the position of responsibility the greater the demand for the exercise of this power. Some men are naturally much more ready and fluent of speech than others, but the quality of fluency is not so much what is required as the qualities of accuracy and clearness, definiteness and brevity, tact and judgment. The genius or the expert, of course, needs none of our advice; but most of us who are average people know that to obtain skill in any direction requires of us attention, application, and practice. We must take ourselves as we are, and not as we would like to be; and by making the necessary effort we may obtain, at least to some extent, the qualities which some possess as a natural gift.

There is, indeed, an art in saying the right thing in the right way, and in the fewest possible words. An authority was once asked by a beginner if he would give him a hint as to how to make a good speech. The reply was: "Have something to say, say it, and sit down." In business the subject is usually ready to hand; but there are occasions—as, for instance, in the making of reports, or representing certain views and interests before individuals or committees, or boards of directors—where a general statement has to be made, but where a definite subject is not so obvious.

In such a case our first business is to think the matter over until we are perfectly clear in our own mind as to the subject or subjects to be dealt with, and as to the object, aim, and purpose of the remarks we are about to make. If we are not clear and precise it is certain that those who listen to us will be no more clear, when we have finished, than we are ourselves—probably much less so. We must have no vague and misty ideas about the subject, but they must be crystallized and definite. These qualities of our thought and speech, however, cannot be left to chance. They are attained as the result of effort, of careful and independent thought on the subject for ourselves, of looking at it from many points of view, and thus satisfying ourselves and those who listen to us that we thoroughly understand what we are talking about. It clears one's own mind in thinking out a subject to talk it over with a colleague, or to write out a statement of it, or to dictate it to a shorthand writer.

In arranging the method of our remarks no hard-

and-fast rules can be given, because they would vary so much with circumstances; but it will probably be of assistance to mention some heads which might be of use, such as the following: Subject to be discussed; aim and purpose of our remarks clearly defined; facts as evidence, and proof of our statements; facts illustrating effects and results; illustrations by use of comparisons, contrasts, and parallel cases; conviction from personal experience as to the reasonableness and importance of our contention; points of view—antagonistic and friendly—considered; summing-up, and re-statement of object in view.

In the case of reports, the headings might include: What we have done; how and why we have done it; what it has cost; the effects and results; what we have got; what we want; what we propose to do; how and why we propose to do it; what the probable cost is; can we afford it? can we afford to do without it?

It is a good plan to write each heading that we intend to use on a separate sheet of paper, and then to arrange our material under the suitable headings, afterward combining them in a logical order.

Having decided what to say, and having properly arranged it, the last point is: How to say it. The first essential is to speak distinctly, then to be natural, straightforward, lucid; neither to strive after effect nor to exaggerate, but to give the impression that we are ourselves convinced of the cogency and force of our own contention. By this means we may hope to be successful in making our remarks productive of the results which we desire.—Technics.

A TRANSPORTABLE SEARCHLIGHT.*

By DR. ALFRED GRADENWITZ.

THE multiple uses of projectors have resulted in the most varying designs of such apparatus, each of which is intended to meet some special requirement. The important rôle incumbent on them, especially in modern warfare, has been evidenced by the Russian-Japanese war as it is being conducted on land and on sea. Overland projectors have, it is safe to state, been used to any large extent for the first time at this juncture, while on board all large modern warships, projectors have for years past been indispensable.

On account of the increasing importance assumed by projectors in connection with land warfare, one type designed by the Siemens-Schuckert Werke, of Berlin, and which has been used in actual practice, will be described in the following:

The projector represented in Fig. 2 is fitted with a mirror accurately ground to parabolic shape. The mirror is 35.433 inches in diameter and has a focus of 14.96 inches. In the focus is located the crater of the positive carbon, which, during operation, gives off its light against the mirror, from which it is reflected and emitted in practically parallel rays. To protect the mirror and lamp and to avoid any lateral escape of light rays, the mirror is surrounded by a housing fitted with the proper openings for ventilation, through which the hot combustion gases of the carbon are carried off. There is also a door in the housing for observing the arc, and the front of the same is closed by several strips of glass as clear as it is possible to obtain.

The projector has been made transportable and is mounted on a four-wheel cart, carrying at the same time in front a box with any necessary tools and polishing material, and on the back, likewise in a box, a cable drum containing about 150 to 200 meters of double cable to connect the projector to existing mains or else to a transportable current-generating plant.

Conditions will very rarely be so favorable as to allow of the projector covering the ground freely. In most cases it has to be raised, to enable the light beams to overcome at least such obstacles as are interposed in the immediate neighborhood. The housing has on this account been made movable and can be lifted about one meter. During transport, the housing is lowered, so as to place the center of gravity of the whole cart as low as possible, and to damp as far as possible the influence of any oscillations on the projector. By this favorable position of the center of gravity, the vehicle is enabled readily to deal with the worst routes and even to accompany riding artillery.

The projector can be designed with electro-motive distance drive, providing both for the horizontal and vertical motions of the housing. Each of these movements is effected by a small electric motor operated by the observer at a distance of 100 to 200 meters from the projector by means of a button switch, and for this purpose a special connecting conductor is obviously required. The great advantage of this arrangement is that the observer, on the projector being installed laterally, is enabled far better to recognize the illuminated field than if he were compelled to look nearly throughout the length of the light beam close to the projector. From his lateral post he will be able to distinguish the shadow of any object as produced by the beam so that the object comes out distinctly.

The intensity of the beam of light given off by the projector is about 61,000,000 normal candles with 90 to 100 amperes. By its aid an efficient telescope will enable men engaged in field work or else striking projectiles to be recognized at a distance of a mile and a half. Larger objects, such as buildings or the like, can be recognized up to about 4½ miles in case they stand out against a suitable background.

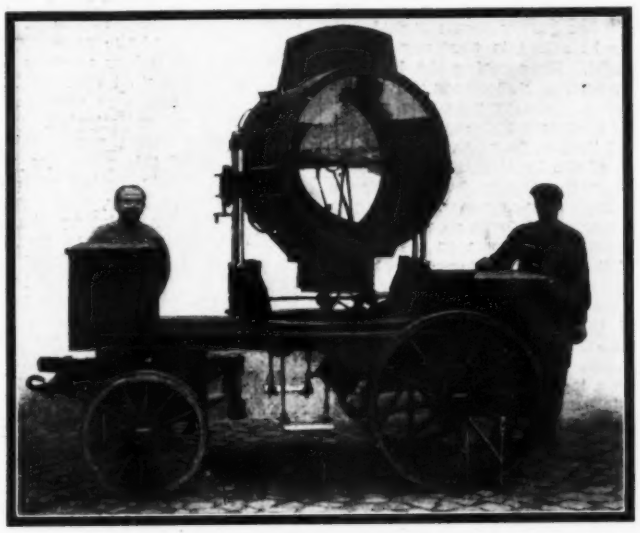


FIG. 1.—PARABOLIC REFLECTOR.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

GOLD EXTRACTION BY CYANIDE: A RETROSPECT.*

By JOHN S. MACARTHUR.

THE circumstances which led to the invention of the cyanide process were these:

About midsummer of 1886 the Cassel process of gold extraction, by the solvent action of electrolytically-generated chlorine, was attracting attention. The process was at the stage of large-scale testing, with works in London under the charge of the inventor, H. R. Cassel, when suddenly circumstances compelled him to abandon his post, leaving the affairs of the Cassel Gold Extracting Company in great confusion.

Having had occasion to look critically into this process, and in course of writing an article on the subject for a weekly journal, I came to the conclusion that the same result could be accomplished without the electric current and without nascency, by the use of chlorine or bromine in presence of a salt which (*a*) would not absorb chlorine or bromine, (*b*) would not precipitate gold, (*c*) would precipitate base metal compounds.

Perhaps there is no salt that absolutely fulfills these conditions, but bleaching powder and borax and bicarbonate of soda approximate to it. I proved that chlorine and bromine, along with such salts, did dissolve gold, but the action on pyritic and base-metal compounds was less easy of proof. At any rate, this method was tried on a sample of gold ore with such success that a research syndicate, consisting of Dr. R. W. Forrest, Dr. W. Forrest, Mr. George Morton, and myself, was formed to investigate and, if possible, develop the process into a commercial success; but we failed in this, for again the halogen, notwithstanding the moderating effect of the added salts, worked too vigorously and spent its expensive energy on the base metals, and to our disgust neglected the gold.

At this juncture, the directors of the Cassel Gold Extracting Company requested me to perfect the Cassel process, and the arrangement was completed on the footing that the Cassel Gold Extracting Company should have the first right to acquire any discovery which might result from the efforts of the MacArthur-Forrest Research Syndicate.

We soon found that our sub-alkaline halogen solution was not to be effective; but, encouraged by the confidence of our far-seeing financial partner, we continued our researches to find a gold solvent that would not be a base-metal solvent. Naturally this excluded all reagents of the aqua-regia type, and restricted us to solutions alkaline to test paper, or at least neutral.

Having regard to the many who, like ourselves, were then searching for a process of extraction, and to the fact that results were frequently reported from the difference between original assay value of the ore and final assay value of the residue—a method frequently open to grave objection—we decided not to consider as extracted any gold unless we actually handled and weighed it. As the most generally useful and applicable precipitant of gold we used sulphureted hydrogen.

Among the various solvents on our programme for trial, we had included potassium cyanide; in November, 1886, we tried the effect of it on the tailings of one of the Indian gold mines, and, as usual, treated the solution with sulphureted hydrogen for recovery of the gold. Getting none, we passed on to our next solvent, meanwhile observing our rule of labelling the residue and laying it aside. We had neglected to notice that sulphureted hydrogen did not precipitate gold from its solution in cyanide, and thus our experiment was, for the time, literally relegated to the shelf.

About eleven months afterward, I had occasion to devise a rapid method of gaging approximately the gold content in weak solutions of gold chloride, and used for the purpose tin chloride to produce the well-known purple of Cassius. One solution that I had to test contained mercury, and, using potassium cyanide to separate the mercury and the gold, I was apprised of the fact that sulphureted hydrogen did not precipitate gold from its cyanide solution. Instantly my mind reverted to the experiment carried out nearly a year before, and I saw that it might have been successful without the success being recognized. Immediately a sample of rich concentrate from a California mine was treated, and on this occasion we examined the residue rather than the solution, and found a high percentage of extraction. A sample of poor concentrate from India was then treated, and again a high extraction was obtained.

The results were startling. We unearthed the residues from the old experiments (all our work was done in duplicate) and to our intense satisfaction we found that they, too, had transferred their gold to the cyanide solution. There was then no doubt about the importance of the discovery, and at once a provisional specification was drafted and lodged. The guidance on this subject to be obtained from chemical and technical text books were scanty, meager, and sometimes misleading. We could get no information whatever on the action of cyanide solutions on gold ore, and no direct or useful information as to the action of cyanide on the ores of base metals. We did get, however, some infor-

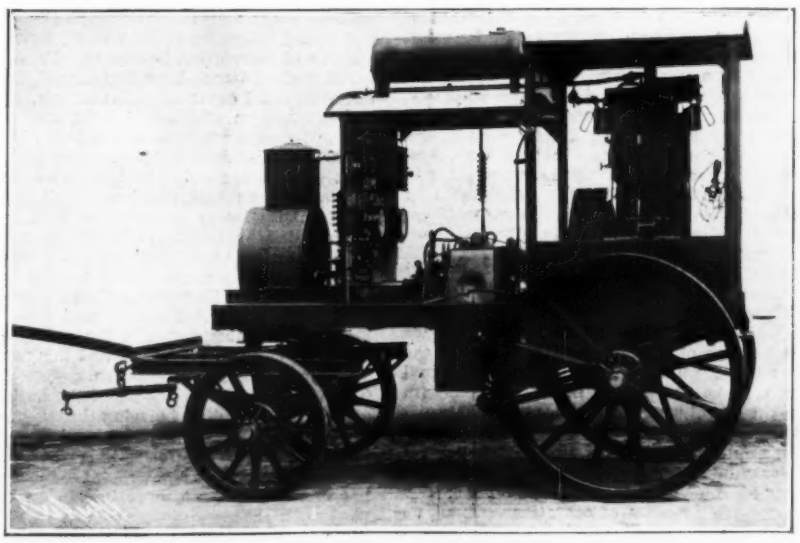


FIG. 2.—SEARCHLIGHT FOR MILITARY USE.

* Abstract of a paper read before the Scottish Section, Society of Chemical Industry, March 7, 1905. Jour. Soc. Chem. Ind., April 15, 1905.

mation regarding the action of cyanide solutions on the metals themselves.

Amid all the confusion of authority, we had to work out a metallurgical process rather than attempt to solve delicate chemical questions concerning reactions among pure materials. On the general assumption that the addition of oxygen, or at least air contact, was necessary for the chemical action, we constructed our first apparatus with a wonderful arrangement of plowshares which turned the ore, sloppy with cyanide solution, over and over, always exposing fresh surfaces to the air. This apparatus gave such good results that we tried the simplification of plain stirring, which also did well, and we came down to a revolving barrel, which did equally well. After this we came down to a plain percolation of the cyanide solution through the ore, which gave such satisfactory results that we concluded that, even if air contact or oxygen were necessary, it was not necessary to devise any special form of apparatus to introduce air to the mixed ore and cyanide solution.

So far, we had dealt with the problem of getting the gold into solution, which was by far the most difficult part of the question. The precipitation from solution was comparatively easy. We knew well that zinc precipitated gold from its cyanide solution; but it remained to make this reaction industrially applicable. We used various forms of finely divided zinc with more or less advantage; but a picture of some fine zinc shavings, bought with other things in a shilling box of chemicals in my boyish days, haunted my mind, and repeatedly I described it to one of the works foremen without effect, until one day, when making a zinc case for packing cyanide, he made a shaving by a sharp tool and asked me if that was what I wanted. My reply was, "Yes," and in half an hour he had prepared the first bundle of zinc shavings for gold precipitation.

We had, of course, to design an apparatus for using the zinc. Here the difficulties of small-scale work hampered us seriously. It seemed such an easy matter to put the zinc in a jar with a hole at the bottom and allow the gold-cyanide solution to run through it; and this simple scheme did very well for a few hours; but gradually the interstices in the zinc mass became choked with extremely fine precipitated gold, the solution flowed more and more slowly, till finally the zinc mass became impervious and the solution overflowed. A small tank, really a water-tight box, with compartments arranged for the well-known alternate up-flow and down-flow, was used; but the down-flow compartments did not work satisfactorily. Finally, the form now in use, in which the down-flow is through zinceless compartments and the up-flow through zinceful compartments, was devised in its first form by the metallurgists then in charge of the MacArthur-Forrest installation in New Zealand.

Zinc precipitation is one of the weak points in the process. With care, the precipitation is complete to a few grains per ton, but the gold is collected in such fine mud, drying into dust, that loss is inevitable. Various modifications have been suggested in the method of precipitation, to avoid this and other inconveniences. Zinc itself has been used in the form of a fine dust which was mixed with the cyanide-gold solution into almost an emulsion. The gold was quickly precipitated and the gold precipitate with a large excess of zinc allowed to settle, and was then collected. This, however, did not get over the trouble of the gold being in soot-like dust, liable to loss with each breath of wind. This method was worked in conjunction with the cyanogen-bromide modification of the cyanide process by Messrs. Sulman and Teed.

When solutions are very weak in free cyanide, or when they contain copper, they are not easily precipitated by zinc in the ordinary manner (though the difficulty in weak solutions has been greatly exaggerated); but this difficulty has been overcome by using zinc coated over with precipitated lead. This is carried out by adding a small quantity of a lead salt to the gold-cyanide solution as it enters the zinc box. This method was devised by me, and patented in 1894. The application for a patent in the Transvaal was refused on an objection lodged on behalf of the Chamber of Mines—thus the process dropped out of sight in the Transvaal until 1898, when it was rediscovered by Betty, who worked it successfully. The introduction of the lead-coated zinc had much to do with the desertion of the electro-precipitation process.

It is not easy to enumerate the advantages conferred on the gold industry and on the world generally by the cyanide process. It adds directly to the world's output of gold about 20 per cent and indirectly very much more, because of greater profit accruing to the cyanide operations, which permits mining and mill amalgamation to be carried on in conjunction with them where they would not have yielded enough profit to stand alone. In fact, in many cases where ordinary milling would not recover enough gold to pay for itself and for mining, cyanide steps in, recovers another moiety of gold at a cheap rate, and makes a profit for the complete chain of operations. Thus, an industry of the two stages of mining and milling might not be able to exist where, with cyanidation added, the industry obtained a new lease of life. Speaking generally, this may be said to be the case in South Africa. If cyanide were to be withdrawn from the Rand, the huge gold industry now so firmly established would dwindle and in many individual cases die. This is true, in a degree at least, of many gold fields.

To Bleach Ivory.—Wash the ivory carefully with liquid ammonia, then with soft water, and finally apply a solution of hydrogen peroxide.—La Nature.

THE LIGHT-PERCEIVING ORGANS OF PLANTS.*

THE subject of this most suggestive book has already been dealt with by the author in a preliminary way.† In its present form it has gained greatly in force and interest, and whether or no we are finally converted to Prof. Haberlandt's views there can be no doubt that they are worthy of serious attention.

It is well known that the majority of leaves have the power of placing themselves at right angles to the direction of incident light, but the question of how the light stimulates the leaf to perform the curvatures and torsions which bring it into the "light position" is a problem which hitherto has hardly been attacked.

The first question to be solved is what part of the leaf is sensitive to light. By covering the blade of the leaf with black paper, etc., Haberlandt shows that the principal and most delicate sensitiveness resides in the blade, although a coarser and secondary sensitiveness to the incident light is found in the stalk. It results from this part of the inquiry that the lamina of the leaf must contain the organs for light-perception, if such organs exist. Anything corresponding to a visual organ may be expected to be on the surface, although in such a translucent organ as a leaf this does not necessarily follow. It may, however, be said that Haberlandt is amply justified in looking for what he calls the ocelli of plants in the epidermis covering the upper surface of the leaf. We may, therefore, narrow the problem thus. Imagine a horizontal leaf illuminated by light striking it obliquely from above at 45 deg.; such a leaf is not in the "light position," and will execute a curvature through 45 deg., in fact until it receives light at right angles to its surface. Then curvature ceases and the leaf remains in a state of equilibrium—satisfied, as it were, with the "light position." The question is how the leaf differentiates between oblique and perpendicular illumination. Direct observation suggests an answer. If the epidermis of such a leaf as that of *Begonia discolor* be removed by a surface section, and mounted upside down and illuminated from below, then with a low power of the microscope it can plainly be seen that there is a bright spot of light on the basal (inner) walls of the epidermic cells. It can further be seen that the relation of the spot of light to the surrounding zone (which is more or less dark) changes when the specimen is obliquely illuminated. Thus in the case of the obliquely illuminated leaf we should have to imagine that the leaf is stimulated to curvature by the fact that the spots of light are not central in the cells, and that curvature ceases when the brightest illumination is once more central. Thus the plasmic membrane of the basal wall of each epidermic cell is supposed to have a quasi-retinal function by which the leaf is believed to orientate itself in regard to light. There is here, as Haberlandt points out, a certain resemblance to the mechanism by which plants are by many botanists believed to react to gravitation, namely, by the pressure of solid bodies on different parts of the cell walls, just as the statoliths (otoliths) of certain animals, by pressure on different parts of the membrane of the statocyst, enable them to orientate themselves in space.

Haberlandt shows that the epidermic cell is well fitted to concentrate light. It is very commonly lens-like in form, its outer wall being convex, its inner wall either plane or curved. Haberlandt shows by geometrical construction that, taking the refractive index of the cell sap as equal to that of water, the focus is usually at a point either within the cell or below it in the other tissues. In either case a central illuminated region and a surrounding dark zone is produced on the basal cell wall. A further development of this type is the papillose epidermic cells which give the velvety appearance to certain tropical leaves. This does not differ essentially from the first described type, but it has, according to the author, certain advantages which will be referred to later on. It must not be supposed that all leaves have lens-shaped epidermic cells; some leaves, known as aphotometric, are indifferent to the direction of incident light, and even in photometric leaves Haberlandt shows that discrimination is possible without the epidermis playing the part of a lens. Where the outer wall of the epidermis is flat, it often occurs that the inner wall bulges into the subjacent tissues or projects into them in the form of a truncated pyramid. In this case, when the light strikes the leaf at right angles, the central part of the basal wall, being more or less parallel to the surface, is more strongly illuminated than its peripheral parts, which are oblique. Thus without any lens-effect we get stronger illumination in the central region of the basal walls of the epidermis; and this may conceivably serve as a means of orientation.

The most conclusive proof of the author's theory is given by the results of placing the experimental plants under water. If he is right in claiming a lens-function for the epidermic cells, it is clear that immersion in a fluid which has approximately the same refractive index as the cell sap must interfere with the plant's power of light-perception; and this is, in fact, the outcome of his experiments.

His first experiments were made with the hop (Humulus). Here, as in other cases, the stimulus of light is perceived by the leaf, and less perfectly by the leaf-stalk. Four leaves were immersed, two (*d*) having their leaf-stalks darkened with tin-foil, while the stalks of the other two (*l*) were exposed to oblique light. After three or four days the *d* leaves showed no signs of taking up the light position, while the two *l* leaves showed well-marked curvature toward that position. The experiment is of importance, since it shows that immersion in water does not prevent heliotropic curvature by interfering with respiration or by depressing the energy of the plant in any other way. The only explanation seems to be that of the author, viz., that in the leaves (*d*) with darkened stalks the lens-like epidermic cells of the leaf-blade are the only organs of light-perception, and they being thrown out of action by the presence of water, perception (and therefore curvature) is absent.

Experiments of the same type were made with a like result on *Ostrya vulgaris* and *Begonia discolor*. It is to be regretted that the light-perceiving organs of such leaf stalks as were sensitive to light under water were not investigated.

A striking result was obtained with Tropæolum. The leaves of this plant are unwettable, and when immersed remain coated with a silvery mantle of air. The waxy layer, which gives this quality, may be removed by painting the surface with dilute alcohol without injury to the leaves. The result of immersion is that the normal leaves protected by a layer of air react normally to oblique illumination, whereas the wettable leaves have lost the power of so reacting. This interesting result suggests to the author a new function for the waxy "bloom" of leaves, i. e., that it saves them from being blinded by a shower of rain. This theory he extends to velvety leaves, the strongly papillated epidermic cells of which stand up like islands when the surface of the leaf is wetted. This is a striking fact in relation to the distribution of velvet-leaved plants, which are especially common in damp tropical regions.

Another section of Haberlandt's evidence depends on the existence of highly specialized lenses. One of the most curious is that of *Fittonia Verschaffeltii* (Acanthaceæ). Here we have a dwarfed, two-celled trichome, of which the apical cell has the form of a biconvex lens. In this case there is a division of labor, the light focused by the lens-cell being perceived by the large basal cell. Direct experiment shows that, as might be expected, painting the leaf with water in no way interferes with the effect, since the lens is raised above the layer of wet. Similar ocelli occur in *Impatiens mariannae*, and here, as in Fittonia, it is interesting to note that the ordinary epidermic cells, among which the ocelli occur, are markedly bad lenses.

Quite a different type of lens occurs in *Campanula persicifolia*; here the formation of a spot of light does not depend on the form of the epidermic cell as a whole, but on the existence of a lens-shaped silicified region in the outer wall of the cell. These structures only occur in perfection in a shade-loving form of the species, where they were noted by Heinricher, who was unable to suggest a function for them. Direct observation proves that they are highly effective lenses. Similar organs are found in *Petraea volubilis*. We must pass over a number of other interesting specialized organs, but it is of importance to note that whenever ocelli occur they are to be found on the upper, and not on the lower, surfaces of leaves. It is also particularly interesting to find that ocelli tend to occur especially near the edges of leaves, i. e., just in those regions where the amount of movement, corresponding to curvature through a given angle, is greatest.

The author has once more earned the gratitude of his fellows by his suggestive discoveries and speculations. He must be allowed to have made out a strong case for his theory, but he would be among the first to grant that more work is needed before it can be considered as completely established.

* "Die Lichtsinnesorgane der Laubblätter." By Dr. G. Haberlandt, o. ö. Professor der Botanik a. d. Universität Graz. Pp. viii + 143 (Leipzig: Engelmann, 1905.) Price 6s. net.

† *Berichte d. deutsch bot. Gesellschaft*, Bd. xxii., 1904 (February), and in an address given in 1904 before the Gesellschaft deutscher Naturforscher und Aerzte, and published by Barth, of Leipzig.

THE IMPORTANCE OF INVESTIGATIONS OF SEEDLING STAGES.*

THE selection of the title, "The Importance of Investigations of Seedling Stages," for presentation before the Section of Vegetable Morphology of the International Congress carries with it the suggestion that it is the intention of the writer to epitomize the recent attempts made to solve the problem of the phylogeny of Monocotyledons by reference to the anatomy of seedlings. The importance of these investigations is beyond question and the unexploited nature of the field has never been better expressed than by Miss Sargent, whose name occupies the most important place in these discussions, when she remarked that while theoretically the embryo should offer characteristics of unusual taxonomic importance, the only character so far of recognized value seems to be that employed in the separation of the two great divisions of the Angiosperms.

But this work has already been brought to the attention of botanists by foreign and American writers, and I speak of it only incidentally in passing to the consideration of some other, though related, points, omitting, of necessity, many interesting and suggestive illustrations which would require far too much space for their adequate discussion.

The recent revival and defense of the conception of the cotyledon as homologous with the nursing foot of the lower forms rather than with foliar organs has suggested many problems which will require a broad comparative study of all embryonic stages for solution.

The functions performed by the cotyledons are various—the protection of younger embryonic regions, the

* Read before the International Congress of Arts and Science, St. Louis Exposition.

deeper planting of the young seedling, and above all, elaboration, storage, and absorption of food material, or in other cases the cotyledons are merely vestigial structures. If it be maintained that the cotyledon is homologous with a more primitive nursing foot and that the Dicotyledons are derived from the Monocotyledons by a bifurcation of an originally simple member, the whole series of adaptive modifications of the cotyledon must be studied and arranged in series in agreement with their origin.

This presents problems of no mean magnitude, physiological and morphological, the solution of which demands the accumulation of a vast series of comparative data. Not only do the differing degrees of physiological specialization and morphological modification of the cotyledon among Monocotyledons offer problems of interest and importance, but the evolution of epigean and hypogean cotyledons in the Dicotyledons must be more satisfactorily traced. If the close resemblance of many cotyledons to foliar organs is merely similar structural adaptation to the same physiological function, the problem is not *solved*, but the point of view is simply changed, since the origin of such adaptations offers a group of knotty problems which will require painstaking research for their solution. If the cotyledons of many Onagraceæ are the homologues of haustorial organs, what is the nature and action of the "correlation" which demands that the portion of the cotyledonary lamina interpolated after exposure to the light shall have a structure and venation in close agreement with that of the true leaves which follow rather than with the simple form and tissue of many other cotyledons which are photosynthetically active for a long time?

If, on the other hand, the old and generally accepted view is considered the correct one and cotyledons are regarded as foliar in nature, the series of forms is almost as puzzling and as much in need of broad and comparative investigation and arrangement.

The morphology of the cotyledon has been called into question through a consideration of the relationship of Monocotyledons and Dicotyledons. Apparent transitions from one great group to the other have been discovered. These apparent transition stages have been used to support two antagonistic views of the relationship of the two great groups. It is apparent that the special data so far secured are very meager and, if it exists, the connection between the two great groups must be established by the discovery of a more complete series of transition stages. If, on the other hand, the forms to which so much significance has been attached are merely adaptations to peculiar life conditions, assumed by a plant at an exceedingly plastic stage of its development, the problem of the relationship of the two great groups seems to be farther than ever from a satisfactory solution.

The value of seedling characters for the tracing of phylogenetic development in families and lower systematic groups and an understanding of past changes both in the race and in its environmental conditions, has been emphasized by several writers. The most satisfactory results in this field are those obtained by Ganong and Cockyane, who have both worked principally with xerophytic forms which offer especially promising material for such researches, though here extreme caution must be exercised in deciding whether distinctive characters of the adult are not merely an expression of the direct influence of the environment upon a plastic organism, while the juvenile stages, owing to the different conditions of growth, are not subjected to these influences, and consequently all the potentialities of their primordia may be realized instead of intercepted and diverted or modified by powerful environmental influences. It scarcely need be suggested that here experimental morphology and ecology have before them material for a series of very interesting monographs.

A field in which results of especial interest may be expected is the comparative investigation of the later developmental stages within the same systematic group. For families Ganong has presented a masterly treatment of the Cactaceæ and Willis has accumulated some data for, and suggested the importance of, such work in the Podostemaceæ, while Miss Sargent's work on the Liliaceæ, when it appears, will doubtless represent the most extensive study of the kind ever undertaken. In other families there is a large store of details waiting for supplementary researches and correlation. The results so far obtained show beyond question the interest, ecological, morphological, and phylogenetic, attached to the study of these groups. While I would not discourage the investigations of these larger groups, it must be admitted that in the present state of our knowledge there are many uncertainties connected with the generalizations concerning their phylogeny, and for the present especial importance should be attached to the investigation of the minor groups, particularly the genera. We have little right to assume the monophyletic origin of the most of the families, while with the genus this is more justifiable, though even here the greatest caution must be used. The embryonic stages, especially the later ones, should be of the greatest value in just this connection, for theoretically they ought to furnish us with an indication of form prevailing prior to the assumption of the more specialized adaptive characters.

But before we may draw conclusions as to the phylogeny of a group or conclude whether monophyletic or polyphyletic in its origin, from characters offered by the later embryonic stages of its members, we must first understand thoroughly the seedling and its reaction to all the factors influencing it. This is a field not for comparative work alone, but for physiological, ecological, and experimental morphological investigations as well. Comparative studies are of the highest importance, but in this case they must be carried out upon material of systematically homogeneous nature. Until the appearance of Prof. de Vries's epoch-making work no one has had available for study a series of forms unquestionably descended from the same ancestor. It is highly desirable that some one take up such types as the new elementary species of Prof. de Vries for the purpose of ascertaining in how far there is a relation of ancestral characters and to what extent there is in the seedling a working back into the embryo of the characters of the adult. While the new species of *Œnothera* described by Prof. de Vries are the simplest systematic units, there are some very suggestive points to be found in his descriptions. The relative stages of development at which the differential characteristics of the new species make their appearance seem not without significance. In some there is an immediate and complete obliteration of the *Lamarckiana* characters, while in others, as in the "avatism" of *O. nanella*, the new characters replace those of the old only at a later period of development. Such cases as that of *Trifolium*, in which there was a working back into the embryo of the divided condition of the leaf as the number of leaflets characteristic of the mature plants increased offer suggestion for an important phase of statistical investigation. Investigations of the seedlings of some of the teratological "varieties" may be expected to yield results of great interest, especially when taken up from the experimental and historical point of view.

The chief object of the study of seedling stages, phylogeny, is dependent for its realization upon the validity of the recapitulation theory. In many cases this seems to hold, but, as pointed out above, a broad, comparative investigation of minor groups is imperative. Results of importance are assured. Developmental stages in the same group will generally show either a close similarity or present a series of perplexing differences. The conclusion in the one case will be that community of descent or identical environmental conditions are responsible. In the other case—and of this a considerable number of striking illustrations might be cited—polyphyletic origin of groups hitherto supposed to be monophyletic must be assumed, or the differences must be accounted for on the ground of adaptation or mutation and the importance of ontogeny as a key to phylogeny greatly restricted. With reference to seedling stages the statement that ontogeny recapitulates phylogeny must be made with great reserve. Doubtless it has here an evolutionary significance, but its application is a matter of serious import. It seems to me that in vast numbers of cases, the sweeping back of later developed characters in the nature of adaptations to environment or otherwise has obliterated ancestral features, especially the superficial ones, to such an extent that an attempt to reconstruct the phylogenetic tree is quite out of the question.

In the examination of seedling stages, experimental morphology may find, as we have already suggested above, a fertile field for research in the determination of the degree of plasticity of juvenile and adult types. Some structures seem to be merely the result of the direct environmental influence, but others cannot be modified by the changing of conditions. Some characters seem to be well fixed, while others are apparently merely the product of immediate influences of the environment. While phylogeny is the chief end, experimental morphology may find in seedling stages material of value for use in the formulation and solution of some of its fundamental problems.

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SOME NOTES ON THE STARS.

WHEN persons desire to impress us with an idea of enormous quantity, they often refer to the sands of the sea, the leaves of the trees, or the stars in the sky. Undoubtedly the total number of stars is enormously great, but most of them, perhaps 9,999 out of 10,000 are invisible to the naked eye. The number of lucid stars is surprisingly small, scarcely more than 2,000 being visible at any one time, and of these there are only nine of the first magnitude in the northern hemisphere. The apparent brightness of a star depends upon two causes: the quantity of light which it actually emits, and its distance from us. Astronomers divide all stars into numbered classes, the number which expresses the apparent brightness being called the magnitude of the star, the brightest ones being spoken of as of the first magnitude. The intensity of light from one magnitude to another varies about in the ratio of 2½ to 1; that is, a standard first-magnitude star is about two and one-half times as bright as one of the second magnitude, a second-magnitude star about two and one-half times as bright as one of the third magnitude, and so on. The sixth-magnitude comprises the faintest stars that are visible to the naked eye. It must not be supposed that all the stars in one class are of exactly the same degree of apparent brightness, for they actually vary by every degree of brilliancy. This gradual variation is expressed by decimals, as, for example, Polaris is of magnitude 2.2. Photometers have been invented for measuring the quantities of light emitted by the stars. But even with them the results depend largely upon the judgment of the observer. The difficulty of reaching strict results as to magnitude is increased by the fact that the stars differ in color. The differences in color are not very great, but they are nevertheless quite appreciable even by the naked eye. When two stars of apparent equal brightness to the eye, but of different colors, are observed with a telescope, they no longer appear equal, but red and yellow stars appear relatively brighter than the green or bluish ones. This further complicates matters. Recently photography has largely been employed in examining the stars. Their magnitudes can then be determined by the effect of their light upon the sensitive plate. But owing to the fact that blue light has a much greater photographic effect than red light, the effect is to increase the apparent magnitude of the bluish stars, and to diminish that of the red and yellow ones. It follows that estimates of star magnitudes by different observers vary considerably, and the most that can be done is to bring about the best attainable agreement between them in the general average of all the stars.

The study of astronomy is one of the oldest sciences. The ancients imagined that they saw figures of heroes and animals outlined in the heavens, and grouped the stars into constellations and named them accordingly. Thus we have Hercules, Perseus, Andromeda, Pegasus, etc. Ordinarily the largest star in a constellation is called Alpha, the next Beta, etc., but this rule is not always strictly followed. Thus in Orion the largest star, Rigel, is Beta Orionis, while Betelgeuse is called Alpha Orionis, although only a third as bright. As the constellations of the ancients did not cover the entire surface of the sky, but left blank spaces between groups, modern astronomers have ignored the old figures and divided the heavens into irregular patches each of which contains not only the entire figure of the ancients, but is so extended on all sides as to leave no blank spaces. But as all astronomers are not agreed as to the outlines of these extended constellations, a star is sometimes put in one constellation by one astronomer, and in another constellation by another. The safest way to identify a star is by its right ascension and declination.

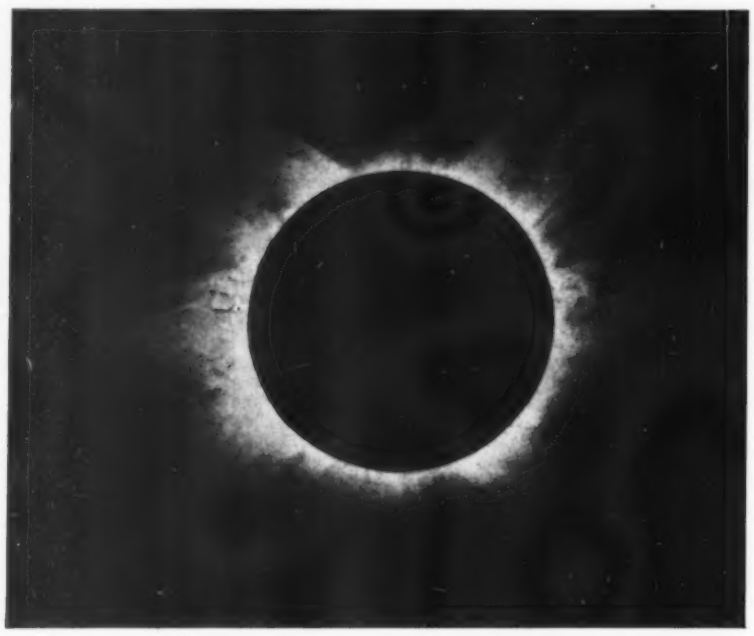
Right ascension in the heavens corresponds to longitude on the earth, and declination in the heavens corresponds to latitude on the earth. If we suppose the plane of the earth's equator to be indefinitely extended, it will make an imaginary circle on the apparent dome of the heavens called the celestial equator, and will divide the heavens into two hemispheres. The axis of the earth being also extended in both directions to infinity will make two points in the heavens known as the celestial north and south poles. Corresponding to meridian circles on the earth we have imaginary celestial meridians in the heavens. Corresponding to parallels of latitude on the earth we have parallels of declination on the celestial sphere. Stars north of the celestial equator are said to have a plus declination, and those south of it to have a minus declination. The zero point on the equator from which right ascension is measured is the point of the vernal equinox, or the point where the apparent path of the sun amid the stars crosses the equator in the spring. Declination is measured by degrees from +90 deg. to —90 deg. Right ascension is measured by hours from 0 to 24, 24 hours being equal to 360 deg., or one hour to 15 deg.

Many attempts have been made to number and catalogue the stars, the oldest being made by Ptolemy about 150 A. D. This list contains 1,030 stars. About fifty years ago a celebrated astronomer named Argelander commenced the work of cataloguing all the stars of the northern hemisphere down to the ninth magnitude. This work gives the magnitude, right ascension, and declination of over 324,000 stars. A similar catalogue is in course of preparation for the southern hemisphere, giving all stars to the tenth magnitude, about half of which is completed, and which it is estimated will contain more than 1,150,000 stars. It has been observed that the number of stars of any given magnitude is about three and one-half times the number of the next brighter magnitude. For example, there are about 500 stars of the fourth magnitude, and about 1,750 of the fifth magnitude, etc. Estimates of the total number of stars vary greatly, but it is probable that there are hundreds of millions of stars within the observation of the telescope, and beyond that no one can tell.

Much has been determined regarding the nature and constitution of the stars by what is called the spectrum analysis. It is well known that when light passes from a medium of one density into a medium of a different density, its rays are refracted or bent, and that waves of different wave lengths are dispersed and form a strip of elementary colors called a spectrum. Different bodies when luminous give different kinds of spectra according to their constitution, their temperature, and the substances of which they are composed, thereby enabling the investigator to ascertain by the spectrum of the remotest star much of its constituents. When a spectrum is formed of distinct bright lines, the star is a transparent mass of glowing gas. When the spectrum is continuous, the star is either an incandescent solid or an opaque incandescent gas. When the spectrum is continuous, but crossed by dark lines, like the spectrum of the sun, the star is an incandescent mass surrounded by gases cooler than itself, the chemical constituents of which may be determined by the position of the lines.

To all astronomers the problem of the structure of the universe was of the profoundest interest. Two famous theories were proposed to explain the apparent motions of the sun, moon, and stars. The Ptolemaic theory held that the earth was immovable in the center of the celestial sphere, and that all the heavenly bodies revolved around us. The Copernican theory held that the sun was the center, and that the earth and the planets revolved around it, the stars being fixed. The great objection to the latter theory lay in the fact that although the earth in its orbit crossed a space 180,000,000 miles wide, yet no measurable difference appeared in the positions of the stars. No one conceived that

the stars were hundreds of thousands of times as remote as our sun, and it was not until 1838 that instruments sufficiently delicate were invented to determine the apex of the triangle formed by a star as the apex



THE TOTAL ECLIPSE OF AUGUST 9, 1896, PHOTOGRAPHED BY BADEN-POWELL.

and the 90,000,000-mile radius of the earth's orbit as the opposite side. The expression "parallax of a star" means the angle subtended by the semi-diameter of the earth's orbit as seen from the star. In the case of all but a few stars this is a fraction of a second of arc, too small to be measured. The greatest parallax yet observed is about 0.75 sec., being that of Alpha Centauri, our nearest neighbor so far as now known.

The study of the stars is of the most enthralling interest, and although much has been learned regarding them, the subject is boundless, and offers fascinating opportunities to the earnest student.—H. S. Manning, Jr., in Yale Scientific Monthly.

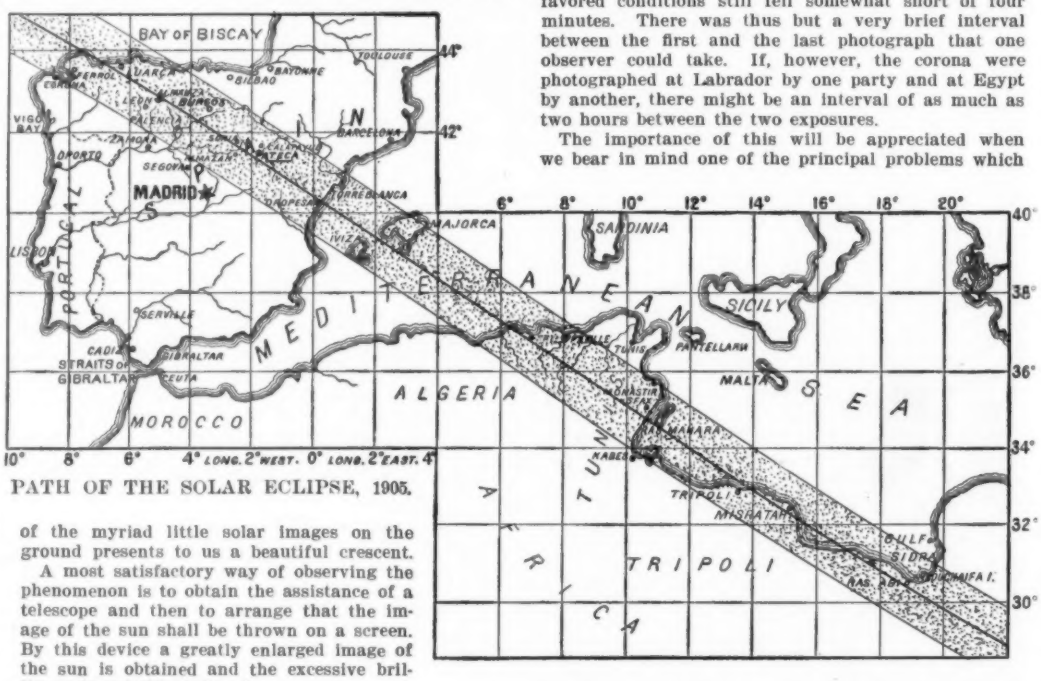
THE SOLAR ECLIPSE.

By SIR ROBERT BALL, LL.D., F.R.S.

THERE have been so many total eclipses within the recollection of most of us that the question may well be asked, why we paid any particular attention to this eclipse of August 30 among the number. The reasons are easily stated. In the first place, the duration of totality at the best stations was fairly long. The complete obscuration of the sun lasted for three minutes and fifty seconds. No doubt under a combination of favorable circumstances eclipses can and do sometimes happen in which the duration of totality, as it is called, is considerably greater. In some eclipses it has been indeed nearly twice as great. On the other hand, in many total eclipses which have been deemed worthy the attention of the astronomer, the precious seconds of totality have been barely half as many as those which was available last August.

The middle of the eclipse, that is, the occurrence of totality at noon, was observed among other places in the north of Spain. There, either at Burgos, or at a place one-third of the way from Saragossa to Madrid, or at Morella, many astronomers were stationed.

The eclipse of August was visible to some extent over the whole of Europe and the greater part of Africa. It was visible over the North Atlantic and over a great part of Canada, and was doubtless noted by many hundreds of thousands of observers. It may here be mentioned that an eclipse of this kind can be observed on a bright day when the sun is high in a manner which, though it may not be actually instructive from a scientific point of view, is certainly pleasing and picturesque. This observation is made, strange to say, not by looking up to the sun, but by looking down upon the ground. When the sun throws a shadow of a tree on the road the rays of light passing through interstices between the leaves form bright spots, which, though we may not ordinarily notice the fact, are really images of the sun. When a large part of the disk of the sun is eclipsed then the bright part is reduced to a crescent, and consequently each



PATH OF THE SOLAR ECLIPSE, 1905.

of the myriad little solar images on the ground presents to us a beautiful crescent.

A most satisfactory way of observing the phenomenon is to obtain the assistance of a telescope and then to arrange that the image of the sun shall be thrown on a screen. By this device a greatly enlarged image of the sun is obtained and the excessive brilliancy is suitably reduced.

But the characteristic phenomena which make eclipses so important are never exhibited when the phase of the eclipse is no more than a partial one. Complete extinction of the sun is necessary, or, in other words, it is necessary for the observer to take up such a position that the shadow of the moon shall pass over him as that shadow sweeps over the earth. It was with the object of getting into the track of the shadow that astronomers visited Canada, Spain, Tunis or Egypt, for the line passed through these other countries as well as through Spain. The width of the shadow track was approximately one hundred miles, but toward each end of the track the duration of the totality diminished, so that to see the eclipse under the most favorable conditions a position had to be taken as near as possible to the central line.

At just 12.41 on August 30 the shadow cone of the moon cast by the sun, after rapidly moving through space, first struck this earth. The place so honored was about Winnipeg, where the rising sun was a black globe. The shadow fell on the earth, and as a black spot about one hundred miles in diameter it commenced an eastern rush at headlong speed across our continents and oceans. In two or three minutes after its arrival it had crossed Hudson's Bay, and then, at just 11.55 o'clock in London, the shadow was launched from the coast of Labrador upon the Atlantic.

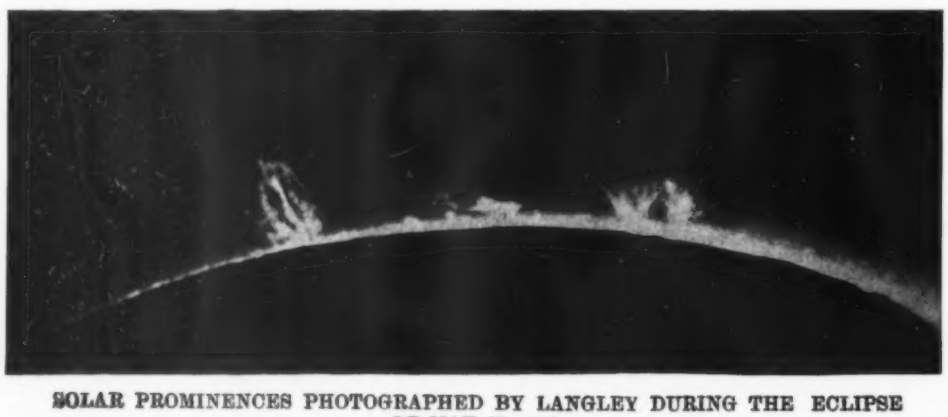
As the Greenwich clock showed 10 minutes to 1, the sun being then high in the heavens, and consequently the opportunities for observation being at their best, the Atlantic journey was over, and the shadow entered Europe near Cape Finistere. For about twenty-five minutes the course lay through Spain, and then the Mediterranean was reached. This sea was crossed till Tunis was entered about 1.40. Then Egypt was entered at 2.04. Twenty minutes later there was a crossing of the Red Sea, and then the earthly journey of the shadow drew to a close, and it ended in Arabia at 2.32, having occupied 2 hours 46 minutes in its course from Canada. At the ends of its track the duration of the totality was about two minutes, and it was nearly double as long in the central part of the track.

Thus at widely distant stations along the track, elaborate photographic appliances for depicting the appearance of the corona and for obtaining information as to its spectrum were busily engaged. This wide distribution of the observing stations made it highly probable that even if the weather were unfavorable in some places it would not be so in all places.

Thus some results were practically certain, but there was another advantage of a very different kind. The duration of the total eclipse under the most favored conditions still fell somewhat short of four minutes. There was thus but a very brief interval between the first and the last photograph that one observer could take. If, however, the corona were photographed at Labrador by one party and at Egypt by another, there might be an interval of as much as two hours between the two exposures.

The importance of this will be appreciated when we bear in mind one of the principal problems which it is hoped this eclipse may have enabled us to solve. The mysterious corona is certainly not a permanent structure. It is in constant movement, and in the intense energy of solar activity the movements occur with such rapidity that in the space of a couple of hours such large changes take place as would be quite conspicuous on the two photographs taken at such an interval. The experience of former eclipses has shown this to be the case, and it may reasonably be expected that further light will be gained by the opportunities afforded in August.

It must be remembered that the corona is never visible unless under the rare opportunity of a total eclipse. The many artificial devices by which it has been sought to exclude the direct light of the sun, and thus render the faint corona visible, have never yet succeeded. Precious, indeed, to those who would penetrate the secrets of nature were those glorious minutes in the afternoon of August 30, 1905.—The New York Tribune.



SOLAR PROMINENCES PHOTOGRAPHED BY LANGLEY DURING THE ECLIPSE OF MAY 28, 1900.

The early perfection of water-culture methods permitted a careful study of the mineral nutrient requirements in the higher plants. Pure culture methods have afforded a more accurate means of studying the needs of fungi and certain algæ. As usually installed, water cultures of the higher plants contain bacteria, so that they afford only a practical test of the requirements. The problem demands some confirmatory tests, at least, under pure culture conditions, particularly when organic compounds are employed. It is possible to grow, in a limited way, higher plants under pure culture conditions.

THE COLORATION OF FLOWERS.

THE flower, that part of the plant whose function it is to perpetuate the species, is also the part which appeals most strongly to the æsthetic sense through beauty of form, brilliancy of coloring, and delicacy of perfume.

Yet it does not differ essentially from the rest of the plant, and all its parts are leaves, more or less transformed. The sepals, which form the exterior whorl, or calyx, retain even the color of leaves. The corolla is differentiated far more strongly and the reproductive organs proper, the stamens and pistils, are so greatly modified that their origin is not evident at first glance. The accessory floral envelopes, the calyx and corolla, play the chief rôle in coloration for which reason horticulturists have devoted especial attention to developing them, increasing the number of their parts and modifying their forms and colors, even at the expense of the reproductive organs, which they endeavor to reduce to the primitive character of floral envelopes.

Methods of Coloration.—Coloration is effected in plants much as it is in animals, though by less varied methods. We may distinguish between apparent or structural colors, due to the play of light determined by the structure of tissues, and real, pigmentary, or absorption colors, due to the presence of coloring matters.

I. Structural Colors.—White is practically the only structural color in plants. White flowers contain, between their cells, numerous air bubbles which reflect light without altering its color. As the incident light is usually white, the flowers appear of the same hue. Furthermore, the air bubbles produce a rough surface which diffuses light in all directions, giving the soft, uniform whiteness so familiar in the lily. It is interesting to note that white hair and white feathers also owe their color to air bubbles.

Some flowers which appear white, however, are in

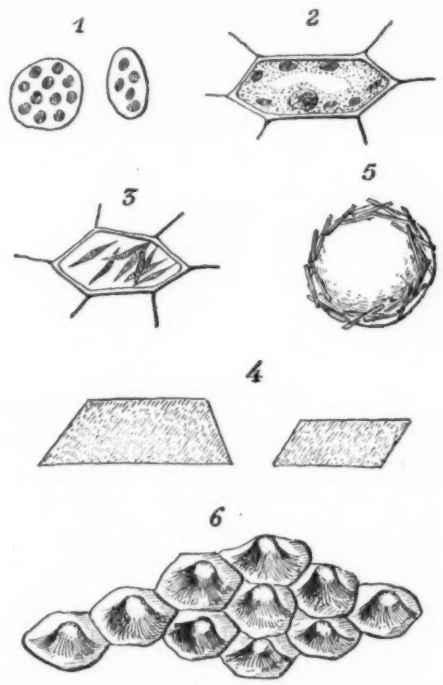


FIG. 1.

1.—Leucites inclosing granulated pigment (amorphous); the chromoleucites of asphodel. 2.—Chromoleucites inclosed in the protoplasm of a vegetable cell. 3.—Fusiformed chromoleucites, inclosed in a cell. 4.—Crystallized pigment (rhomboidal lamellæ). 5.—Pigment needles surrounding a corpuscle colored with Erythroxylon Coca (after Courchet). 6.—Papillæ of the petals of the pansy.

reality merely pale. Their true tint is seen when they are contrasted with white paper.

The velvety appearance of pansies, violets, and some other flowers is also caused entirely by reflection. It is due to the presence of little elevations, or papillæ, on the petals, so that the light is reflected, as it were, from the depths of the tissue as it is in velvet, the fibers of which are normal to the surface.

II. Pigmentary Colors.—Pigmentary colors are due to coloring matters which change the composition of incident light by absorbing some of its components. The pigments of flowers are numerous and of varied character. Though little is known of their nature and affinities it is possible to distinguish two well-defined groups: (1) Undissolved red and yellow pigments, nearly related to chlorophyll, the green coloring matter of leaves; (2) dissolved pigments of various colors which have no kinship with chlorophyll. Of these dissolved pigments the most important is anthocyanine. Besides these two chief groups there are other coloring matters of much rarer occurrence. Among these are saffronine, carthamine (obtained from *Carthamus tinctorius* and employed by the Chinese in the treatment of smallpox), and the group of chromogenes, including indigo, which become colored by oxidation—a property which explains the blue tint assumed by the flowers of *Calanthe* and *Phagus* in withering and on being rubbed.

1. Chlorophyll and Related Pigments.—Chlorophyll plays a very subordinate rôle in the elaboration of flowers. Few flowers are entirely green, though the leaflike calyx usually has this color. The functions of the leaf and the flower are very different. The leaf is an organ of assimilation. The decomposition of carbonic acid and the fixation of the liberated carbon are effected by the green coloring matters known as chlorophyll. The synthesis of complex albuminoids from their elements occurs only in organisms which contain chlorophyll.

But the chlorophyll pigments are not the sole agents in these changes. The grains of chlorophyll are carried by a class of proteid cells propagated by division which, when they contain chlorophyll, are called chloroleucites or chlorophyll bodies. Both the pigments

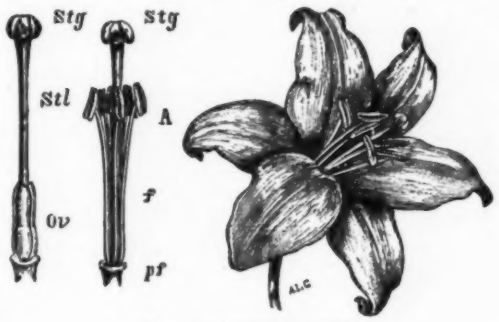


FIG. 2.—WHITE LILY.

and the leucites contribute to the assimilation of carbon. It is generally admitted that the pigments, in virtue of their power of absorbing radiations, store up the energy of sunlight, and that the leucites employ this energy in assimilation. Accompanying the chlorophyll are yellow pigments, termed xanthophylls, which, however, play no part in assimilation. The flower, on the other hand, is the organ of reproduction. In it, assimilating pigments are rare, yet some of its coloring matters appear to be chemically related to chlorophyll. They are carried by leucites (chromoleucites) from which they derive their activity, and may be amorphous, granular like chlorophyll, as in the Crowfoots, or crystalline, as in the Cucurbitaceæ. All these undissolved pigments may be grouped about a few types. The members of one group are yellow, always amorphous and very much alike. They have not been isolated in a state of purity but are believed to consist of the same substance, more or less mixed with foreign matters. The others are red, orange, and yellow, amorphous or crystalline. Most of them are very much alike and are probably identical with caratine, the coloring matter of carrots, which is very widely distributed among plants. The red pigment of the aloe, however, appears to be distinct.

FIG. 3.—PANSY.

The genesis of these undissolved pigments affords another argument for their relationship to chlorophyll. Many flowers are green in the bud and during the development of the flower the grains of chlorophyll may be observed, under the microscope, to grow pale, lose their characteristic color, and become gradually

FIG. 4.—SAFFRON.

replaced by other pigments. But the latter may also develop in leucites previously colorless.

2. Dissolved Pigments, Anthocyanine.—Most of the floral pigments which are found dissolved in the cellular liquid are related to anthocyanine. This coloring matter is the source of the red, rose, blue, and violet tints of the hyacinth, colchicum, campanula, rose, periwinkle, forget-me-not, violet, poppy, sage, borage, larkspur, etc. The color depends on the reaction of the cell sap, being red or rose when this is acid, violet when it is neutral, and blue when it is alkaline. In many plants the reaction of the cell sap is not constant, which fact explains the tendency of certain flowers to pass from blue to rose or from rose to violet.

Polygala vulgaris, for example, may exist in the same locality in blue, rose, and white varieties (the last being destitute of pigment). *Anagallis arvensis* exhibits now blue, now red flowers, and both may be found on the same plant of *Hortensia*. In the Boraginaceæ the flowers are blue or violet when young, but become rose-colored as they advance in age. Contrary to the former belief, anthocyanine is formed independently of chlorophyll. It appears directly where chlorophyll has never existed, and also with chlorophyll but without any causal connection. Thus, in reddening autumn leaves, anthocyanine is formed while chlorophyll turns yellow and disappears, but the

FIG. 5.—NARCISSUS.

two phenomena are absolutely independent of each other.

The chemical nature of anthocyanine is not known with precision. Some authors regard it as a glucoside, resulting from the combination of sugar with the tannin of the cell sap.

There are, also, dissolved pigments unrelated to anthocyanine, but they are comparatively rare. Such are the yellow coloring matters of the dahlia, the opuntia, and some centaureas. So there is no definite relation between the color of a floral pigment and the state in which it exists.

Several coloring matters may co-exist in the same flower. The flame colors of the nasturtium are due to a dissolved red and an undissolved yellow pigment, which occur separately or blended in the various layers of tissue. In the pansy and the Persian iris a gray tint is produced by the combination of a golden yellow granular pigment with a light blue or violet liquid.

Pure black is never found in flowers, which, unlike animals, never contain black pigments, but the effect of black is sometimes produced by dark blue, violet, or purple pigments.

Development of Coloring Matters in the Flower.—

FIG. 6.—POLYGALA.

The transformation of the bud into the flower is accompanied by a change of function. With the chlorophyll disappears the chlorophyllic assimiliation and transpiration diminishes, while respiration becomes more active and the phenomena of oxidation and hydration assume greater importance. The production of coloring matters is due to all these factors. The chlorophyll is replaced by the related but more stable yellow and red pigments xanthophyll, carotin, etc., and, on the other hand, the increased activity of oxidation facilitates the production of an excess of sugar, which combines with tannin to form anthocyanine.

These phenomena are entirely analogous to those of the autumnal coloring of leaves. At the approach of winter the leaves of deciduous plants show a notable diminution of assimilating power and respiration increases while transpiration is lessened, as in flowers. The chlorophyll is destroyed and the leucites become incapable of producing it anew; the more stable xan-

thophyll persists alone and colors the leaves yellow. This is the normal autumnal coloration, but sometimes, as the chlorophyll disappears, a new pigment, anthocyanine, is developed in the cell sap and the leaves turn red. This is the color assumed by the leaves of the Virginia creeper at the moment of their fall and, occasionally in special weather conditions, by those of the grape vine.

It has been observed that the distribution of anthocyanine in the leaf coincides with that of tannin. Furthermore, it is possible to produce the red coloration of leaves by forcing the plant to absorb glucose in excess, to bleach the reddened leaves with reducing agents, which separate the tannin, and to reproduce the anthocyanine and the red color by the action of oxidizing agents.

In both the flower and the autumn leaf, then, the lencites, losing their power of assimilation, become incapable of forming chlorophyll, and other pigments make their appearance. If the vitality of the tissues in general, and the lencites in particular, is too greatly weakened, as in chlorosis, no new pigment is produced and the tissues become filled with air and appear white. Albinism is always a symptom of reduced vitality. White flowers weigh less than colored flowers of the same species.

The essential parts of the flower seem to attract to themselves the materials needed for the development of the embryo, so that the exterior floral envelopes receive a minimum of nutritive substance. They betray their defective nutrition by the inability of their lencites to manufacture chlorophyll and owe their brilliant colors to the appearance of new and more stable pigments.

According to some observers, there is a close relation between the color of the flower and that of the root. Thus, pinks with red roots bear red or pink flowers, pinks with yellow roots bear yellow flowers, etc.

The coloring matter appears to be of some utility to the flower. Experiment has shown that the corolla, in virtue of its absorptive, emissive, and reflecting powers, is able to throw upon the reproductive organs a considerable proportion of the calorific and luminous energy which it receives, and we have seen that yellow, which corresponds to the maximum of luminous intensity in the spectrum, is the commonest color in flowers. Thus the physiological rôle of the floral envelopes is explained—natural and artificial variation of the coloration of flowers.

Color is not a constant characteristic, but is susceptible of great variation. The coloration of flowers is regulated by two factors—heredity and environment. The plant tends to reproduce the characteristics of its parents and more remote ancestors, but it must also adapt itself to the conditions of its existence. The color of a hybrid is not necessarily a mixture of those of its parents, for the plant may inherit any or all characteristics from either parent alone. The hybrids of a red and a white flower do not present a mixture of these colors, for the peculiarity of one parent is simply the absence of color, but some of the hybrids are red, others white.

Of the new characteristics which are produced by natural hybridization, only those persist which are useful to the species, and which are thus perpetuated by natural selection.

The horticulturist imitates this process by producing numerous variations and selecting those which appeal to his æsthetic sense. Thus have been obtained double flowers in general, the central spot or "eye" of the pansy, the regular distribution of blossoms on gladiolus, our "hybrid perpetual," and other roses, monstrous chrysanthemums, etc.

But the production of new varieties by hybridization consumes much time and, despite all theories, it is largely a matter of chance. Hence, attempts have recently been made to utilize varieties produced by grafting, in which, as in sexual reproduction, there is a fusion of protoplasms and, consequently, variation.

The egg plant, grafted on the tomato vine, bears fruits which resemble tomatoes, together with the normal fruits of the egg plant. New species have been obtained by grafting the mediar on the hawthorn, and one species of *Malvaceæ* on another.

External conditions of food supply, moisture, heat, and light, also influence the color of flowers by affecting nutrition and, hence, the production of pigments. Certain salts, such as nitrates, and compounds of iron and copper, favor the development of chlorophyll, while the salts of lime, common salt, and others have an injurious effect, and cause chlorosis. A blue coloration may be produced in the hortensia by mixing with the soil g.ound slate, ammonia, and sulphate of iron. White flowering varieties of hyacinth and colchicum are obtained by keeping the bulbs in darkness.

To the action of light may be attributed, also, the progressive increase in intensity of coloration with increasing altitude which is shown by *Myosotis silvatica*, *Campanula rotundifolia*, *Ranunculus silvaticus*, etc. The effect is due, partly, to the increased amount of light received by plants growing at great elevations, and partly to peculiar climatic conditions (intense illumination by day, and low temperature by night) which favor the production of anthocyanine by the combination of tannin with the excess of sugar manufactured during the day, the escape of which from the flower is prevented by the nocturnal cooling.

Change of coloration with the latitude is explained by variations in the conditions of environment, heat, light and moisture alike being abundant in the tropics and deficient in the polar regions. White flowers increase in frequency as we recede from the equator. From Hoffmann's observations, continued through eight years, it has been learned that the white lilac blooms six days earlier, on the average, than the purple lilac. This might appear to be a curious anomaly, without special significance, had not similar observations been made in regard to varieties of radish and crocus. In the former, twelve years' observations give a mean precocity of sixteen days for white as compared with yellow varieties. In the crocus, the difference is only four days.

Changes of tint often appear under the influence of heat. The white lilac, which first appeared in commerce in 1858, was produced by exposure to a temperature of 85 to 95 deg. F. It cannot be affirmed that the white flowers found in nature have the same origin as the artificial white lilac, as experimental data on the subject are lacking. A yellow variety of *Papaver alpinum* is found in the polar regions, and white varieties have been discovered in Switzerland. In cultures of the same species in Germany it has been found possible to obtain white flowering plants by metamorphosis of yellow flowering plants. It is impossible to say whether heat is the cause of the change or not.

We know only a small part of the changes in coloration brought about by external conditions. Perhaps experiment, by isolating the various factors, may yield data upon which the horticulturist may create new marvels.—Translated and abstracted for the SCIENTIFIC AMERICAN SUPPLEMENT from an article by Dr. H. Mandoul, in La Science au XXme. Siècle.

CONTEMPORARY ELECTRICAL SCIENCE.*

ALPHA RAYS OF RADIUM.—Since it has become known that helium develops out of radium, it is interesting to find at what stage of the evolution helium is first met with. E. Rutherford has, therefore, studied the α-rays of radium with regard to their velocity and their ratio of charge to mass to find whether the α particle is an atom of helium. He adopted the usual method of measuring the deflection of a pencil of homogeneous rays when passed through a magnetic and electric field of known intensity. He measured the amount of magnetic deviation accurately, but did not yet succeed in measuring the electric deviation with equal accuracy. Hence the question is still open, but the author discovered several interesting facts. By passing the rays through an absorbing screen of thickness d and density ρ, the range in air was found to be reduced by the distance ρd. This is an expression of the fact that the absorption of the rays is proportional to the density of the matter traversed. In a thick layer of radio-active material of one kind, the rays emitted into the gas come from different depths, and consequently pass through a distance in air varying from zero to their maximum range. This means a complexity of the rays, which is further increased by the products of disintegration. When a thin film of radium is used, matters are simplified. Using an intensely active deposit on a wire, the author obtained 2.6×10^9 centimeters per second for the velocity, and 6.5×10^3 for e/m in electromagnetic measure. The wire was made active by exposure to radium emanation. The active deposit consisted of radium A, B, and C. Since radium A is half transformed in three minutes, and radium B is rayless, the above values are those applying to α particles projected by radium C. The ionizing, phosphorescent and photographic actions of the α-rays emitted from radium C cease after traversing very nearly the same distance of air. This is surprising considering that the α particle then still possesses a velocity at least 60 per cent of its initial value. It shows that these effects cease at a certain minimum velocity. The author give reasons for believing that this critical velocity characterizes all the actions of the α particle, whether on solids, liquids or gases. If, therefore, the particle is too slow to ionize the gas, it is also too slow to affect the photographic or fluorescent plate. The author advances a third theory of the spinthariscope. The scintillations may be due to the recombination of ions produced by the bombardment. The author brings important reasons for believing that the disintegration and transmutation of matter may be going on at a great rate in "non-radio-active matter," but below the critical velocity, and, therefore, not discoverable.—E. Rutherford, Philosophical Magazine, July, 1905.

ACTINIUM.—T. Godlewski describes the new product of decomposition of actinium discovered by him, which he calls actinium x by analogy with radium, thorium, and uranium x. The activity of actinium, from which actinium x is removed, increases so that the recovery curve is approximately complementary to the decay curve, as in the case of thorium. There is, however, a well-marked difference. After removal of Th x, thorium has always a certain amount of residual activity, about 25 per cent of the maximum value. A similar effect is observed in the case of radium, where the "deemanated" radium has always a non-separable activity of about the same value. In the case of actinium, immediately after the removal of Ac x, the actinium is almost inactive, its activity being only 5 per cent of its maximum value. Another fundamental difference between actinium x and thorium x is that the latter gives off α-rays only, while the former emits α, β and γ-rays. Actinium itself is rayless, whereas thorium gives off α-rays. Otherwise there is the same succession of products in both. First comes actinium, then actinium x, changing half into emanation in ten days, then half into Ac A in 3.7 seconds, then half into Ac B in 36 minutes, and then half into rayless Ac C in 15 minutes. The β-rays from actinium are quite homogeneous, and the γ-rays fairly so.—T. Godlewski, Philosophical Magazine, July, 1905.

RELATIONS BETWEEN RADIO-ACTIVE SUBSTANCES.—R. J. Strutt has studied the amounts of uranium, radium, thorium, and helium in various minerals, with the object of throwing some light on their probable origin and parentage. He confirms the conclusion that the amount of radium in a mineral is proportional to the uranium, having found uranium in several minerals which, like monazite, were hitherto not supposed to contain any. There are in every mineral approximately two-millionths of 1 per cent radium bromide to every per cent of uranium oxide they contain. This proportion is very constant, varying between three-millionths for Virginia sipilite and 0.8-millionth in Virginia monazite. The solitary exception is the pyromorphite of Issy l'Evêque, studied by Danne, which contains no uranium. But in this case the radium has been shown to be probably due to infiltration. The author has never found a thorium mineral free from radium, though the converse is often found. He suggests that thorium is the parent of uranium, perhaps through the intermediary of some other metal of the cerium series. It is also the chief parent of helium, for helium is never found without thorium. The proportion varies greatly, but, of course, different minerals would retain the helium with different forces, and they might also be of different ages.—Hon. R. J. Strutt, Proceedings of the Royal Society, No. 508, 1905.

HALL EFFECT AT HIGH TEMPERATURES.—H. R. von Traubenberg has determined the Hall effect in bismuth at temperatures ranging from 15 deg. to the melting point at 270 deg. He employed Des Coudres' method with an alternating current, and found it answer well. He found a negative temperature coefficient all through, the effect diminishing rapidly at first up to a temperature of 150 deg., then more slowly up to 260 deg., and then more and more rapidly as it approaches the melting point. We know, from Drude and Nernst's measurements, that the effect in liquid bismuth is about one-hundredth of its value at ordinary temperatures.—H. R. von Traubenberg, Annalen der Physik, No. 7, 1905.

* Compiled by E. E. Fournier d'Albe in the Electrician.

GENESIS OF THE PLOW.

IT is astonishing how long it took the human race to invent any decent farm implements. For many centuries after he emerged from barbarism and had learned to live by agriculture, instead of first by hunting and then by raising flocks, he went along in the crudest way, making little or no improvements from age to age. His first need, of course, was something with which to stir the soil, and for this purpose he fashioned a stick, which he himself drew. Long afterward, when beasts were trained for burden and draft, the stick was enlarged and drawn by them. At that point, however, agricultural invention stuck. The people who figure in the Bible, covering a period of some twelve centuries, had nothing better by way of a plow than this forked stick. Solomon, with all his wisdom, seemed to have no inventive talent and allowed his people to continue scratching mother earth with this rude implement. They were great in philosophy, could write magnificent poetry and wind off proverbial wisdom by the volume, but not a man in Judea ever produced anything to help along agricultural progress. Even the Greeks, so ingenious in other respects, failed lamentably to help their farmers with tools to save time and labor. The same story comes from all the other early nations, the Assyrians, Babylonians, Egyptians, and every country of Asia. Cyrus, the great Persian, with all his conquests, did nothing for soil culture. It was at a comparatively recent period and only in limited sections that they got far enough along to shoe their plowing stick with iron, and this was the best they did through all the centuries down to a little more than 100 years ago.

Some improvement was made in Great Britain during the eighteenth century in the form of plows, but the primitive instrument remained in common use, generally made by the farmer himself. It is not generally known that Thomas Jefferson invented a plow which he described as having "the moldboard of least resistance." It did not come into general use, however, but is interesting as showing the ingenuity of that many-sided man. The first American patent on a plow was granted to Charles Newbold, of New Jersey, in 1797. It was a cast-iron affair and a good stagger in the right direction, but Jethro Wood laid the foundation for the modern plow. He gave it its present form and made it of cast iron, patented in 1819. About twenty years later plow making became extensive, and finally John Deere, the pioneer inventor, brought the plow to its present perfected state. The original cultivator, like the original plow, was a hooked stick, which in time developed into the hoe, and this remained the common cultivating implement until the nineteenth century was well advanced. Early in the last century Jethro Tull originated, in England, the horse-shoe system of cultivation, and in 1856 George Esterly took out a patent on a straddle-row, two-horse corn cultivator. That was the beginning of the present almost endless variety of this class of farm implements. The earliest demonstration of a successful reaper was made by Cyrus Hall McCormick, in Virginia, in the summer of 1831, and this was the great forerunner of all the modern reapers. If the United States had done nothing more, its contributions to agricultural invention would have entitled it to high rank as an international benefactor of civilization and progress.—American Farmer.

ELECTRICAL NOTES

The Marconi Company has installed a service between the Plateau de Cointe and Les Vennes at the Liège exposition in order to acquaint the public with the working of wireless telegraphy. This service will be performed daily from 11 to 12:30 o'clock and from 2 to 4 o'clock. The Cointe station is to serve as auxiliary station of the state telegraphs, the public being allowed there to deliver telegrams to any destination at the ordinary tariff, and to observe the transmission of these telegrams by wireless telegraphy to Liège, whence they are transmitted on by wire.

The present status of the electric furnace may be summed up in the statement that it is to-day proving a most efficient weapon in the siege which man is laying to the secrets of nature; that some of the positions won by it have been occupied with great advantage, and that many more are capable of profitable occupation. It owes its importance, however, not so much to the wonders which it has wrought in the past as to the possibilities which it offers for the future. While it is only in process of emerging from the laboratory stage it has already reached the dignity of an agent whose services can be measured in terms of that sordid but universal unit, the dollar.

An increase of silicon has been found to be accompanied by a quite noticeable increase of the coercive force and of the hysteresis energy loss of steel, while the maximum induction does not seem to be influenced to any noteworthy extent. As the hysteresis loss is thus so largely increased, by reason of the presence of the silicon—a disadvantage by far outweighing the corresponding gain as regards electric resistance—the conclusions to be drawn will be that any addition of that element in making the steel ought, as a rule, to be avoided in the case of sheet material. As to the influence of a similar increment of silicon in cast steel, on the contrary, it appears that the results have proved to be anything but unsatisfactory. The electric resistance is thereby quite noticeably increased, while the properties of permeability, remanence, and maximum induction hardly undergo any alteration. If an amount of silicon be added that will raise the percentage of this element to about 2 per cent there will be a risk of the castings being more or less piped.

One of the most singular difficulties to be faced by a page-printing telegraph on the continent of Europe is the fact that telegrams are not delivered in envelopes. They are folded up so that the address only is visible on the outside and then sealed with a stamp. For this purpose the address has to be inserted in a special position at the top of the telegraph form. In France it has to go on the back of the telegraph form. With the Hughes and Baudot tape-printing telegraphs this presents no difficulty, as the address can be pasted on anywhere. The saving of labor in a page-printing telegraph compared with a tape-printing telegraph, in which the tape has to be cut up and pasted on telegraph forms, is considerable, but there is also a considerable saving of labor in not using envelopes. There are no envelopes to be addressed and there is no possibility of making a mistake in the address. An ordinary page-printing telegraph cannot automatically start printing a telegraph message and then turn back and insert the address at the top of the message, and then turn down and print the text and signature.—Donald Murray, in the Electrical Magazine.

Recent investigations of current variations in telephone transmitters and the effects they produce in the receivers have revealed that only a small percentage of the energy of the sender's voice is required for producing audible speech at the other end of the wire, but it has also been discovered that while certain sounds are so well adapted for telephonic transmission that they are almost invariably heard in almost any circumstances there are others that produce little or no effect and make hiatuses in the communication which sometimes result in complete unintelligibility. In other words, language, if it had been developed only for use over the telephone, would have been essentially different from what it is now. The American Telephone Journal, in discussing this interesting and possibly important subject, says: "Some vowels produce relatively intense sounds after conversion through the transmitter, induction coil, and receiver. Others are weak, however great the vocal effort made. The enunciation of the letter *e* is productive of a current very much less in strength than that arising through the enunciation of either *a* or *o*. These vowels are employed so extensively in the English language that the inequality in the impulses of current produced in the telephone frequently amount to gaps in the current equivalents of the sound conveyed." From consideration of these facts it is suggested that attempts to improve telephonic service should be along the line of meeting conditions where enunciation is lacking and that the transmitter must be studied with this end in view. "Delicacy in microphones," says the Journal, "does not imply either distinctness or carrying power unless the voice is peculiarly adapted to it. The loud reproduction of faint or inaudible sounds is really only the reproduction of some of the sounds. Increased power for certain voice tones is necessary in the further improvement of telephone transmitters. Analysis can be carried out along these lines of reasoning with a definite, practical, and directly applicable purpose in view, that will make possible the ready identification of all voice tones with their known peculiarities, and thus form a basis for future development of transmitters." With all its irritating peculiarities and uncertainties, the telephone has come to be of such enormous value both as a necessity and a convenience, that even as it is it ranks high, if not actually first, among the innumerable gifts of science to the nineteenth century. Of course, we all want better telephones if they are to be obtained, but there is a somewhat general impression that if the companies always did the best they could in "the present state of the art" complaints would be comparatively few.

ENGINEERING NOTES.

The committee of engineers appointed by the commissioner of public works, of Chicago, to examine the underground tunnels in that city, has made its report. The engineers failed to find any settlement due to the first main line tunnels which were built under air pressure. All the settlements found were traced to the work done without air pressure. There have been completed 173,510 feet, or practically thirty-three miles of tunnels, and the work is now proceeding at the rate of about 500 feet a day.

There is at present more uniformity between the designs made by American engineers and those by European engineers. In the early days of iron bridge building, in this country, there was little resemblance between American and European structures. Each country gradually adopted the good points of the other's practice; we adopted their practice in the use of riveted trusses for longer spans and a more extensive use of riveted connections; while the European engineers are adopting the more rational designs and details of plate-girder and riveted-truss construction now used in America. At the present time, the designs of plate girders and ordinary riveted-truss bridges, made in this country, are almost identical with the designs made by the best bridge engineers in Europe, so that no vital difference now exists between American and European bridges of moderate spans.

The fact might as well be recognized at once that the supply of so-called smokeless fuels, anthracite coal, petroleum, natural gas, etc., is limited and will not begin to satisfy the demand. The supply of bituminous coal on the other hand is practically unlimited, and it is doubtless the fuel of the future. The abundance of it, its cheapness, and the readiness with which it burns, even with a poor draft, combine to make it a most desirable fuel. This granted, the further fact remains that it will be burned to a larger and larger extent in the East as well as in the West, and that no legislation can prevent this. Just as anthracite coal becomes more scarce and its price increases, just so surely will its place be taken by the cheaper and more abundant fuel. The problem for our engineers and lawmakers is not how to prevent the burning of soft coal, but how to burn it in such a way that the combustion shall not be a public nuisance.

It was first of all in Germany and then in England that gas-engine construction underwent the most rapid development. Afterward America was the country which produced the greatest number. It is therefore not surprising to notice that each type has retained in its construction or design something which, as a birth-mark, reveals its nationality. The German engine has always presented the appearance of a well-finished machine as regards constructional details—all the parts machined were usually polished bright, which disclosed a real anxiety on the part of the makers to impart a high finish to their machines. This, of course, affected the price, but the life of the engine was materially increased thereby. There are cited as examples of longevity certain "rack" engines of the Otto-Langen type and make, which are completing a career of thirty years' service.

The essential point to be observed in all steel work is to prevent, if possible, the first development of rust, for once begun it is much more difficult to arrest than in iron; for this reason, oiling of all material for a steel bridge, at a very early stage of its existence, cannot be too strongly insisted upon. This practice, however, makes the work so objectionable, and even dangerous when being lifted—because of the liability to slip—to the men engaged upon it, that it is commonly very difficult to insure it being done sufficiently soon to satisfy a careful inspector. If the work is carried out under cover, the requirement is less urgent. Strictly, all material should be oiled so soon as rolled, but the writer does not remember to have seen this done at any of the mills he has visited, though it is common enough to find it specified. Iron-work does not need the extreme care which should be bestowed upon steelwork, but it is desirable that it should be painted as soon as possible, the surfaces being first thoroughly cleaned.

The Organ für die Fortschritte des Eisenbahnwesens publishes the opinions of many German, Austro-Hungarian and Dutch railway managers on nickel-steel. The following were the conclusions arrived at: 1. Axles for locomotives are being made of nickel-steel containing from 1 to 2 per cent of nickel, but no decisive results have been obtained so far. From some experiments that have been made, this nickel-steel appears to have a greater capacity for resisting surface injuries than crucible-steel. 2. Parts of driving-gear made of nickel-steel containing from 5 to 7 per cent of nickel gave satisfactory results, but have no advantage over those made of the material ordinarily employed for this purpose. In the opinion of several managers the additional expenditure for material and manufacture has not been justified. 3. Fire-boxes made of nickel-steel and nickel ingot-iron (proportion of nickel unknown) did not prove durable and had to be replaced by copper fire-boxes after a short trial in consequence of serious leakages through the seams and cracks proceeding from the holes for the roof-stays; moreover the manufacture was attended with considerable difficulty and required half as much time again as with copper. 4. Fire-box bolts of nickel-steel (proportion of nickel unknown) were not found durable. They became leaky after a brief period of working; the working was very difficult on account of the hardness of the material and proved exceedingly expensive. Nickel-steel has consequently not fulfilled all the expectations entertained at its introduction.

SCIENCE NOTES.

It is yet regarded as a mechanical paradox that a medium without friction should have waves set up in it by molecular vibration, and little is known of the physical relations existing between matter and ether by which electrical and magnetic phenomena are produced, and one may say that of the nature of ether we know nothing. Think of the amazing extent of it. As limitless as space itself, with no break or separation of its parts, not made up of particles like matter, but completely filling space and so constituted that any movement of a particle of matter in some way affects the whole body of it to the remotest part of the visible universe.

There is little lard made from hogs fed on cotton-seed meal; for extensive investigations at the agricultural experiment stations have shown that while the meal is a rich, cheap food, it proves in many cases in an unexplained way a poison to the hogs, and so many of them die of eating it that few growers care to risk its use. But it is indisputable that some cotton-seed meal is fed to hogs, and some of the lard may get on the market; and Mr. Elton Fulmer, of the Washington Agricultural Experiment Station, who has conducted extensive experiments in feeding hogs on the meal, has shown that pure lard from hogs so fed will give as strong tests for cotton-seed oil as lard mixed with 15 per cent of the oil itself.

The legislation relating to pure food is a matter of the utmost sanitary importance. The regulations of interstate commerce which omit sanitary conditions are altogether incomplete. In fact, it appears that a very large proportion of our legislation which really concerns the public welfare should be accomplished with the advice, the vote, and consent of the medical profession, and yet out of more than 400 members of the national congress only three have had any medical training. The congress of the future will contain not less than 1 per cent of trained medical men, but let us hope as much as 25 or 30 per cent. Again, there is no reason why a medical training should unfit a man for other duties in connection with public life than those relating to sanitary measures. There is no reason why a physician should not make a good president as well as a good major-general, a good governor, or a good mayor, a good member of the common council, and especially most excellent commissioner of sewers.

Was the trite saying, "Every man to his taste" ever better exemplified than by the almost incredible custom, said to prevail in parts of China, of using castor oil as a cooking grease, as lard is used in America? A less surprising but, as judged by American standards, almost equally uncommon custom is the use of this oil in British India and in some other Oriental countries as an illuminant. In British India it is reputed, among other uses, to be extensively used as a lamp oil, and reports of no ancient date even refer to it as the illuminating agent in railway cars. Castor oil also has in some countries extensive uses as a lubricant. In Australia, which imported 769,392 gallons in 1898, the chief use is officially stated to be for this purpose, and the decline in imports in 1902 to less than 500,000 gallons is attributed to the substitution for this vegetable product of the mineral product, petroleum. It may also be noted that in the Cape of Good Hope, where the oil is probably largely used for the same purpose, 307,728 gallons were imported in 1902. To a limited extent this oil is used for lubricating purposes in the United States. As is well known, the mechanical function of lubricating oils is to form a coating or cushion between rotary surfaces, thus keeping them free from contact and preventing loss of power through friction. To this purpose castor oil, being heavy bodied, viscous, and non-drying, is in most cases well adapted. It is the heaviest of fatty oils, having a density of 0.96, and is particularly adapted to the oiling of fast-moving machinery because the heat generated keeps it in a liquid state. In the oiling of special kinds of machinery, carriage wheels, etc., it is still used to a small extent in the United States; but for general lubricating purposes the cheaper but lighter-bodied mineral oils, to which the required viscosity is frequently given by the admixture of resin, have almost completely supplanted this as well as other oils. The esteem in which castor oil was popularly held as a lubricant, however, is suggested by the fact that petroleum products adulterated with resin are in some instances now sold upon the markets under the designation of "machine castor oil." Castor oil also has properties that adapt it to use in the dressing of leather, and a demand for limited quantities exists in the United States, especially in country districts, for domestic use in oiling and softening boots, shoes, and harness. Among minor uses may be mentioned its use in the manufacture of "sticky fly paper" and of the so-called "glycerine soap." For some of its varied uses it is apparent that the demand for castor oil in the United States has declined; for others, especially in recent years, it has increased. The resultant of these opposing forces, however, is that consumption as a whole is on the upward trend. Quantitatively, the consumptive demand for this product in the Unite-

States is now probably at its maximum up to this date, and absorbs in round numbers about 1,000,000 gallons annually.

TRADE NOTES AND RECIPES.

To Remove Ink Spots.—Oxalic acid, 10 grammes; chloride of tin, 2 grammes; acetic acid, 5 grammes; water, 500 grammes.—Formulaire.

Solutions for Cleaning Metals.—Various liquid mixtures are employed for this purpose. Here are two formulas: 1. Water, 20 parts; alum, 2 parts; tripoli, 2 parts; nitric acid, 1 part. 2. Water, 40 parts; oxalic acid, 2 parts; tripoli, 7 parts.—Formulaire.

Ink for Designs.—Boil together 60 grammes of shellac and 45 grammes of borax in 300 grammes of water, and prolong the boiling until the whole is reduced to the volume of ¼ of a liter. Then incorporate in this liquid 50 grammes of lamp-black and the same quantity of gum-acacia.—La Nature.

To Clean Store Windows.—For cleaning the large panes of glass of store windows and also ordinary show cases, a semi-liquid paste may be employed, made of calcium of magnesia in purified benzine. The glass is to be rubbed with a cotton rag until it is quite brilliant.—Science Pratique.

Dextrine Mucilage.—This may be used particularly for the advance preparation of labels, which will afterward adhere perfectly to glass when the face is slightly moistened. It is prepared by simply dissolving in hot water a sufficient quantity of dextrine to furnish a paste of the consistency of honey.—Revue Chronométrique.

Lye for Bleaching Cotton and Linen.—This is composed of the following proportions:

Hydrated sodium oxide	0.227
Liquid sodium perchlorite, free from lime	0.900
Nitro-benzol	0.002
Candurango colorant	0.001
Water	0.370

—Science Pratique.

Roof Covering.—In an iron receiver melt over an open fire 190 kilogrammes of resin, and add gradually 100 kilogrammes of anthracine oil. Take from the fire and pour into the receiver 60 kilogrammes of crude benzol, while stirring carefully. Pour into this mixture, still gradually, 200 kilogrammes of ordinary bole, while continuing to stir rapidly. Leave it at repose for a time, but filter while the mixture is still warm.—Science Pratique.

Lining for Acid Receptacles.—Plates are formed of one part of brown slate, two of powdered glass and one of Portland cement, the whole worked up with silicate of soda, molded and dried. Make a cement composed of ground slate and silicate of soda and smear the surface for the lining; then, while it is still plastic, apply the plates prepared as above described. Instead of these plates, slabs of glass or porcelain or similar substances may be employed with the same cement.—Chemiker Zeitung.

Hygroscopic Compound.—It is known that a leaf of blotting paper or a strip of fabric made to change color according to the hygrometric state of the atmosphere has been employed for weather indications in place of a barometer. The following compound is recommended for this purpose: one part of cobalt chloride, 75 parts of nickel oxide, 20 parts of gelatine, and 200 parts of water. A strip of calico, soaked in this solution, will appear green in fine weather, but when moisture intervenes the color disappears.—La Nature.

Sympathetic Ink.—Dissolve one part of a lead salt, 0.1 part of uranium acetate, and the same quantity of bismuth citrate, in 100 parts of water. Then add, drop by drop, of a solution of sal ammoniac until the whole becomes transparent. Afterward, mix with a few drops of gum-arabic. To reveal the characters traced with this ink, expose them to the fumes of sulphuric acid, which turns them immediately to a dark brown. The characters fade away in a few minutes, but can be renewed by a slight washing with very dilute nitric acid.—La Nature.

Composition for Linoleum, Oilcloth, and other Coated Articles.—This is composed of whiting, dried linseed oil, and any ordinary dryer, such as litharge, to which ingredients a proportion of gum tragacanth is to be added, replacing a part of the oil and serving to impart flexibility to the fabric, and to the composition in a pasty mass the property of drying more rapidly. In the production of linoleum, the whiting is replaced in whole or in part by pulverized cork. The proportions are approximately the following by weight: Whiting or powdered cork, 13 parts; gum tragacanth, 5 parts; dried linseed oil, 5½ parts; siccative, ½ part.—Revue des Produits Chimiques.

Liquid Antiseptic Soap.—Take 50 grammes of caustic soda of 70 per cent, and free from carbonic acid, if possible, 200 grammes of sweet almond oil, 160 grammes of glycerine of 30 deg. Baumé, and sufficient distilled water to make up 1,000 grammes. First, dissolve the alkali in double its weight of water, then add the glycerine and oil and stir together. Afterward, add the remainder of the water and keep the whole on the water bath at a temperature of 60 deg. to 70 deg. C. for 24 to 36 hours, remove the oil not saponified, which gives a gelatinous mass. Mix 900 grammes of it with 70 grammes of 90 per cent alcohol and 10 grammes of lemon oil, and as much of the oil of bergamot and the oil of vervain. Heat for some hours at 60 deg., then allow to cool and filter on wadding to eliminate the needles of stearate of potash. The liquid after filtering remains clear.—Pharmaceutische Centralhalle.

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